THE ELECTRICAL WORLD

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The New McDonough Telephone.

Mr. James W. McDonough, who is contesting with Mr. Alexander Graham Bell the question of priority of the invention of the telephone, has recently perfected a system of telephonic communication which possesses many novel and valuable features. We are therefore pleased to present a full description of this apparatus and its several features to our readers.

Fig. 6 shows the exterior of the complete apparatus, of which Figs. 8, 9, 10 serve to illustrate the details. Fig. 9 shows the back-board with the box for containing the battery at its lower part. When this board is fastened to the wall it has a number of soft vulcanized-rubber rings placed between it and the wall so as to deaden the effects of mechanical jars of the wall upon the instrument. In fact, in order the more fully to provide for this condition each screw which is passed through the holes in the board has a rubber ring-washer placed over its shank and next to its head, and then a piece of rubber tubing of the length of the thickness of the board next to the ring on the shank. Then the screw is passed into its hole, and has another rubber ring-washer put on its shank. So when the screws are screwed to place there is an elastic substance between the wall and screws and board to deaden vibrations.

The box is made of a size to hold four small-size Leclanché battery cells. This number is often used because the transmitter contacts have so much higher resistance than have others; but the volt-ampères or watts of energy expended are said to be no more than in cases where only one cell is used. That is to say, four cells in series last four times as long as does the one. The six white strips on the board in Fig. 9 represent so many metal spring-contacts, which serve to press on a like number of pins which project from the back of the transmitter-box shown in Fig. 10 and thereby to make the requisite electric connections. This transmitter-box is shown in place in Figs. 6 and 8. The spring and pin contacts are shown at c and c^3 in Fig. 5.

Above the transmitter box in Fig. 6, which is a perspective view of the complete apparatus, is the magneto-call apparatus like that in common use.

Fig. 4 shows in diagram the circuit connections which are made in the back of the back-board. The wires from the battery are connected with the springs *a*, whence the current passes to the microphone and primary of the inductorium in the transmitter-box. The springs *b b* receive current from the secondary of the inductorium, and are connected to line by wires represented by the dotted lines. Wires from the springs *c c* run to the magneto-call, through the binding-posts 3 3.

Fig. 2 is a view of the inside of the transmitter-box looking from beneath; and Fig. 3 is also an inside view looking at the switch-end—that upon which the receiver is hung as shown in Figs. 6 and 8. The most notable feature of the interior of the transmitter-box is the microphone. This is placed in the local primary-circuit, as usual, and *r* and 10 represent the connecting wires.

Referring to Figs. 1, 2 and 5, *E E E* are three four-sided prisms of compressed carbon, and they are fastened to the under side of the thin, wooden diaphragm in the cover of the transmitter-box. The metal clamps *e e* serve to make contacts for the prisms and the wires *r* and 10 fastened to them. *F F F* are ten small carbon cylinders having the form shown by Fig. 7. The ends of these cylinders are given a conical form, but with the bases of the cones turned outward. The cones are fluted so as to give their bases a 5 pointed star-shaped base, like those shown at the right in Fig. 7. The points of these two stars are placed at relatively unlike angles, varying say thirty-six degrees; so that if the rod was placed on two equal-plane supports, one under each end, one star-point would bear on one support, and two star-points would rest on the other support. These cylinders are placed with their star-shaped ends resting loosely in holes made in the vertical sides of the prisms *E E E*. As the cover *S* of the box is somewhat inclined from the horizontal, the shoulder of the lower end of each of the cylinders comes in contact with a side of two of the prisms, thus making some more contacts.

By this arrangement there are two sets of cylinders in series, and five cylinders in each set. But there are four sets of contact-points in series, and 5, 10 or 15 contacts in each set. Under ordinary rough usage it would seem to be impossible to break contact at all these points at once; therefore the circuit is at all times preserved, though its resistance may be varied very much at the microphone, so as to produce corresponding effects in the other apparatus belonging to the telephonic circuit.

The necessary variations of the resistance of the microphone are brought about by the vibrations of the diaphragm *d*. Figs. 2 and 3, on which the microphone is mounted in the manner which has been described. This diaphragm is composed of three layers of veneer, thoroughly cemented together, with the grain of the veneers crossing. It is about $4 \times 6 \times \frac{1}{16}$ inches in size, and is securely clamped to the under side of the cover of the transmitter-box by the clamps d^2, Figs. 2 and 3. Mr. McDonough says he thinks that when the diaphragm is made up of combined straight and curled-grained veneers its resonative vibrating powers are more satisfactory than when made up of veneers having all like grain. About 3×4 inches of the diaphragm are exposed to the action of the voice.

The receiver is shown lying by the transmitter-box in Fig. 10, and hung on its hook, provided for the purpose when not in use, in Figs. 6 and 8. Two sectional views of it, at right angles to each other, are shown by Figs. 11 and 12. The vulcanite case *A* contains the magnet *B*, which is bound against a piece of cork by the clamp *M*. The magnet core is of hardened steel, and has the annular form shown. It is wound with fine wire of the usual size

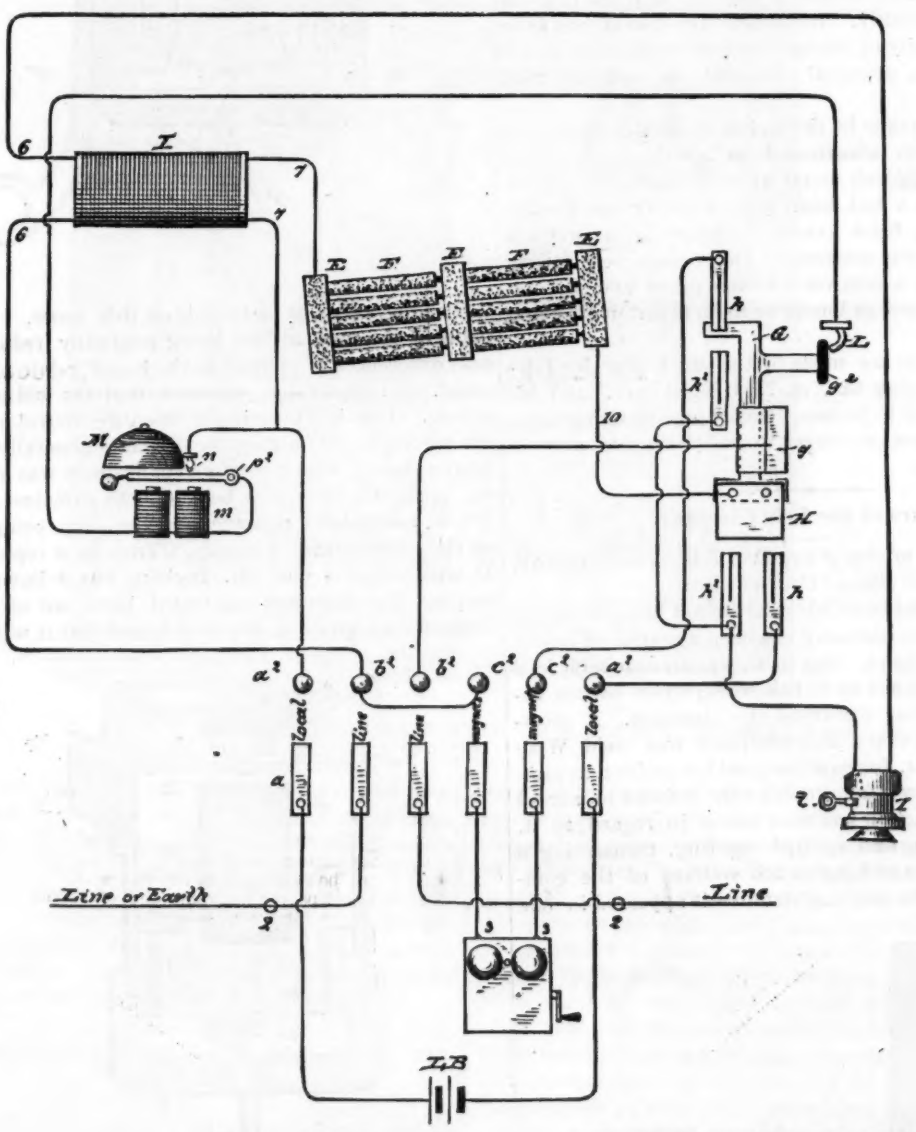
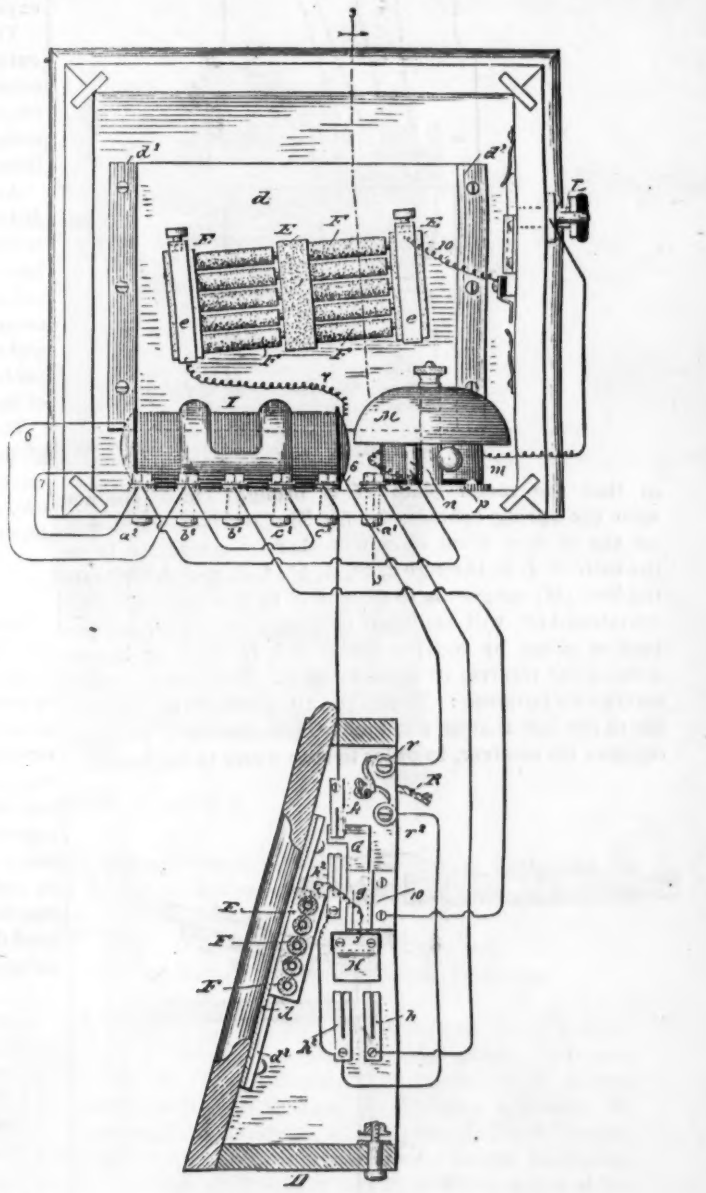


FIG. 1. THE McDONOUGH TELEPHONE SYSTEM.



FIGS. 2 AND 3.

and resistance. The poles *B*, Fig. 12, act upon the armature *D*. This armature is merely a small disc of soft iron about the size of a silver dime. It is rivetted through its centre to the centre of the diaphragm *C*, as at *d*, Fig. 11. The diaphragm is a circular disc of sheet zinc. Mr. McDonough says that he has adopted zinc because by its use he avoids the ringing metallic tones due to the metal of the diaphragms of other receivers.

A cap *E* is screwed over the connecting screws, so that unpleasant contact with them is avoided. A metal arm *F*, Fig. 11, is provided, with which to hang up the receiver when not in use. By the screw *n* electric connection is made between the arm and one of the circuit wires, for a purpose which we will hereafter show.

Fig. 1 is a diagram illustrating the circuits of a complete individual installation. Figs. 2 and 3 also exhibit the circuits, but mainly to show the connections for the operating switch. Like letters in Figs. 1, 2, 3 and 4 refer to like parts. *L* is the hook upon which the receiver is hung when not in use. In order to remove the receiver from the hook, it is necessary to move the switch handle g^2 away from the hook. In doing so, the switch *G* is moved

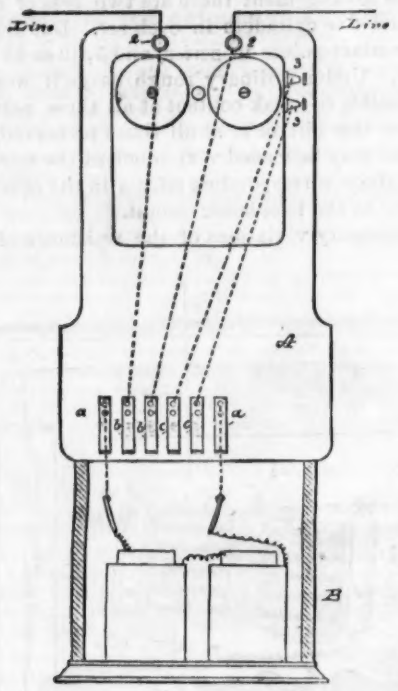


FIG. 4.

so that the metal plate *H* is brought into contact with the spring contacts h^2 *h*. The receiver being still on the hook a local circuit is thereby completed from the battery *L B*, through *a*, a^2, *h*, h^2, *t*, *L*, and the vibrating-bell (*M*) magnet *m* to a^2 and *a* to the battery. The vibrating-bell will continue to ring until its circuit be broken either by moving the switch *G* back or by removing the receiver from the hook *L*. This arrangement serves two purposes: To call the attention of the subscriber to the fact that he must move his switch back when he replaces his receiver, in order to stop waste in his battery,

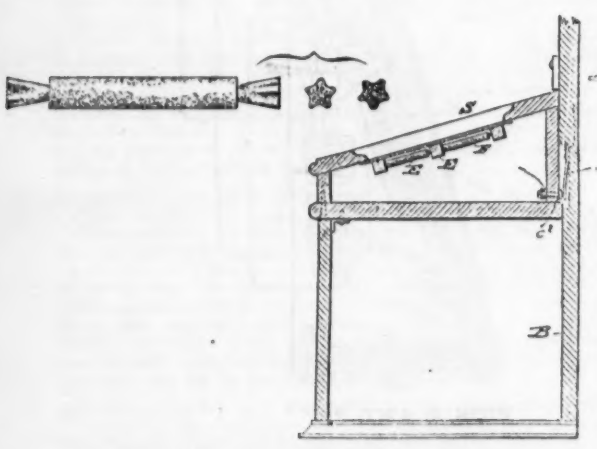


FIG. 7. FIG. 5.

and also to notify the other subscriber, with whom he has been conversing, that he has finished and has hung up his receiver. This latter effect is due to the ringing between times of the bell *M* in the transmitter-box being heard by the other party.

When the receiver is on the hook, and the switch-handle g^2 is forward, the call-circuit is from the magneto call-box 3 to *c*, c^2, *k*, *G*, *g*, b^2 *Line*, back by *Line* to *b*, b^2, c^2, *c* and 3. When the switch is moved back the call-circuit is broken at between *k* and *G*.

The switch being back and the receiver removed, the local or primary circuit is from battery *L B* through *a*, a^2, *h*, *H*, 10, the microphone 7, the primary coils of the inductorium *I*, the other wire 7, back to the battery by the left hand a^2 and *a*. Variations in the resistance of this circuit at that part of it constituting the microphone produces rising and falling alternating currents in the secondary coil of the inductorium *I*.

The course of this secondary circuit may be traced as follows: From the inductorium *I* by the upper wire 6 to the receiver *T*, thence by h^2, *H*, *g*, b^2 to *Line*; back by *Line* or Earth to *b*, b^2, and 6 to the inductorium.

In devising and perfecting this apparatus Mr. McDonough has had in view, not only convenience and efficiency in use, but the greatest possible avoidance of the exceedingly annoying effects of induction from neighboring lines and other extraneous sources. This he has accomplished in a

FIG. 6.

FIG. 8.

surprising degree by the simple expedient of making his transmitter very powerful, and his receiver correspondingly hard to affect. The simplicity, however, lies in the idea. The practical carrying out of the idea has required much experimenting and the exercise of his very extensive experience.

The transmitter practically eliminates the effects of extraneous induction because it does not respond to them other than very weakly. The transmitter is so strong as to obviate the necessity of the use of sensitive receivers which suffer so much in practical efficiency on badly affected lines.

An experiment made by the writer illustrates these conditions. A system constituted as we have described worked exceedingly well under all tests from whisper to loud voice, and on a bad line, with scarcely appreciable noises originating from external sources. But when a sensitive receiver was substituted the noises were strong and annoying, and a loud voice at the other end was repeated at the receiver so loudly as to be heard in all parts of the room.

These instruments are made by the Mc Donough Telephone Manufacturing Co., of New York city, and we understand they are to be energetically pushed into general use, and that several exchanges to use them are now in process of building.

Affairs of the Erie Company.

Referring to the affairs of the Erie Telephone Company, recently, the Lowell (Mass.) *Courier* said:

That the local telephone interests are not being managed in a spirit of perfect harmony has been a matter of public notoriety for some time. But there was an approach to a satisfactory adjustment up to this week, when events occurred that somewhat disturbed the situation. A meeting of the directors of the Erie company was held Wednesday, at which Mr. Ingham resigned his position as president. The board by a unanimous vote refused to accept it, and no further action has been taken in regard to it. The board had a long and spirited meeting, transacting a good deal of business looking to the welfare of the company. Following the meeting statements appeared in one

FIG. 9. FIG. 10.

or two Boston papers which were calculated to make a bad matter worse. It was represented that the company was going to the dogs; that unless a change of management was made a receiver might be asked for; that the company was behind in its account with the Bell people and must pay up or lose its telephones; and similar statements tending to unsettle the not too resolute confidence of the average stockholder. The directors, who, before these publications, were reticent about the meeting in question, now talk more freely, and from their conversation it appears that things are not so bad as they have been represented. They are naturally averse to being quoted by name, but declared that the published stories are wide of the truth. One of them talks like this: The business of the Erie telephone company, considered purely as business, is satisfactory. Differences among the directors do not affect the income of the company. The revenue is derived from letting telephones, and so long as telephones are not ordered out they will earn so many dollars for the company. The subscriber down in Texas who finds the service satisfactory doesn't care what the directors do, and while it pays him to have a telephone will have one and the company will get the benefit. As for the statement that the income for the quarter ending with September is less than for the preceding quarter, the indications are that it will be larger. All the accounts are not in, but there was a gain in business and in receipts. The debt was not increased, as has been stated, but as a matter of fact was reduced by considerable payments to the Bell company. And on this point the director said that the relations between the two companies are very friendly. The Erie has its contract and will live up to it. If it didn't, of course the Bell could proceed against

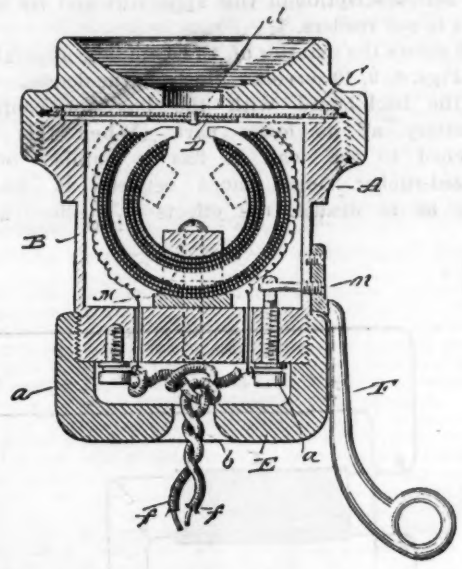


FIG. 11.

it, but there will be no trouble on this score. The other debts of the company are being gradually reduced. The only differences of opinion in the board relate to management. It is generally conceded that the old policy was wrong. That left practically the entire control of affairs to the executive committee, the directors generally never opposing them. Under this system business was not carried on, as the directors now believe, with sufficient prudence. When complaint was made, and the only complaint was on the expenditure of money, there was a rupture. Mr. Downs resigned and Mr. Ingham has followed his example. The directors, as stated, have not accepted Mr. Ingham's resignation, and it is hoped that it will be with-

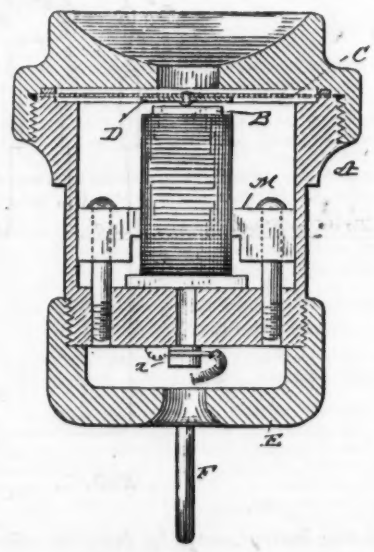


FIG. 12.

drawn. The policy of the board now is to earn every dollar possible, to administer the affairs of the company with the utmost economy, and in general to so conduct the business that the debt may be paid off and the company put upon a sound footing. This they have every confidence will be effected, and before the annual meeting next June they look for a very favorable turn in the tide of affairs.

Now as to the defalcations in the Northwest. There was stealing from the company at different points, principally at St. Paul. At that place a trusted employé had helped himself to sufficient money to start an elegant barroom, taking in a partner. They had bad luck in this venture and the thief could not return the money. When Mr. Jewett went West he looked into the matter and received a mortgage of $5,000 from the friends of the employé, and this is as good as cash. Other defalcations of smaller sums have been discovered, and the money is being collected.

The above account is concurred in by other directors

who were seen. The board is represented as being substantially a unit in favor of the new policy. Mr. Gove, who, it was stated, resigned as a director, did verbally declare his intention so to do, but no action was taken upon it, and it is thought that he will continue to serve. The directors feel annoyed at the publication of untrue stories about the company, and charge the falling off of $2 a share in Erie to their circulation. They say that all the stockholders are interested with them in building up the company, and that all should work together for that end. Managed in a business-like way there is money in Erie, they hold, and they propose to neglect no efforts to prove it.

A Meeting of Erie Stockholders.

An informal meeting of about 40 stockholders in the Erie Company was held at Lowell, Mass., on Oct. 26th, when the affairs of the company were freely discussed. Treasurer Glidden read a statement, which he said represented the debt up to the 8th of October, but did not include the receipts for September. The gross debt was $244,342.77. This was offset by accounts receivable amounting to $43,158.59, and supplies amounting to $33,124.33, a total of $76,312.92, leaving a debt of $168,029.85. There are 2,000 shares of unissued stock in the treasury. It was stated by several large stockholders present who had been out West and examined the books and looked over the exchanges, that the company could easily earn $125,000 yearly. Resolutions were adopted requesting the board of directors to fill the vacancies to the limit allowed by the constitution, and to elect to those vacancies J. W. Bennett and A. W. Sherman, of Lowell, and J. W. C. Pickering, of Manchester, N. H., making 11 directors in all; also to amend the by-laws so that two directors be substituted for the treasurer and general manager in the executive committee. Messrs. Ingham, Glidden and Adams were present and spoke. The meeting was harmonious. The general opinion was of the most hopeful character, and confidence was expressed by many that the company would soon be again on a dividend-paying basis. The new directors recommended were very satisfactory, and it was felt that their presence would strengthen the directory materially.

The Western Electric Co.'s Hotel Fire-Alarm and Room-Call.

It seems almost ridiculous that hotel proprietors should adhere to the antiquated practice of sending a special messenger to the guest's room to find whether he is there, and that they should leave the guest to the uncertainty for a time as to whether his call has been heard or otherwise noticed. The waits for this cause in our enormous modern hotels involve in the aggregate a great waste of time and patience.

When electric wires and bells were substituted for the old pulls it now seems strange that the landlord did not do a little something in the reverse way by placing a bell in each room, so that he might signal to the guest when necessary to communicate, instead of calling up the hall-boy to take his lazy way to carry a message.

Perhaps it was necessary for the inventor and manufacturer to construct a handy apparatus for the purpose, and to mildly suggest to the landlord that he needed such a thing. The Western Electric Co. have done so, and with great success, judging by the numbers of landlords' testimonials they show.

Figs. 1 and 2 show the complete equipment at the hotel office. Fig. 1 is the call, and Fig. 2 is the annunciator. In each room there is an electric bell and a push-button, and each wire is carried to its appropriate drop on the annunciator.

Whenever the clerk at the office desires to know whether the guest is in his room, or desires to signal to him when there, as, for instance, to call him at a stated time, he presses the appropriately numbered button on the call, and the guest answers by pressing the push button in his room. Early calls have been very annoying to guests in neighboring rooms, who too often are awakened by the hall-boy's call not intended for them, while the wanted man sleeps obdurately along. The uses for the call are too obvious to need enumeration.

One of the best features, however, is the facility with which it may be used as a fire-alarm. The centrally pivoted lever has its axle mounted within a strong volute spring, so that when the horizontal catch is moved the lever rotates on its axis by uncoiling of the spring, and causes four rollers (two at each end of the lever) to roll over the buttons in succession without further attendance. Each and every bell in the rooms of the hotel is thus rung by reason of the contacts which close the circuits running from the call to the rooms.

But little apparatus is needed additional to that already employed in hotels using electric bells. Nothing but a bell in each room, and a wire running through the rooms in series.

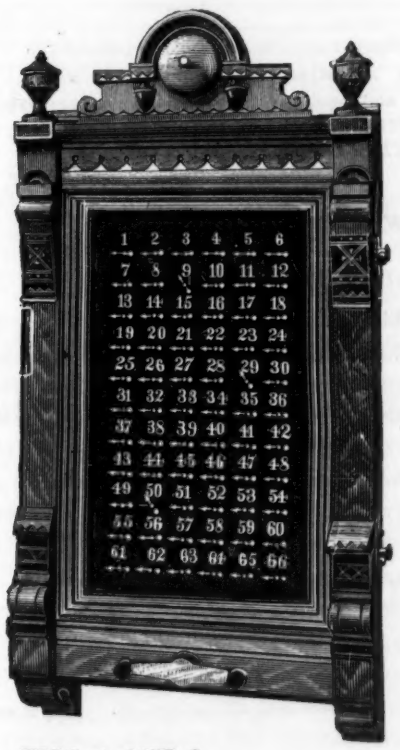
The American Electrical Exhibition at Boston.

The managers of the American Electrical Exhibition have done quiet, but very effective work in the last few weeks, and will surprise and astonish the public with the immense number of novel and entertaining exhibits electricity can produce. The fact that they will not charge for power nor floor space, a charge that was quite high at Philadelphia, has made them the recipients of many applications from parties who have not exhibited anywhere before, and as the development in the electrical science is very rapid, many things will be shown here that the public has never seen, nor even heard of. They now supply for public information the points given herewith.

The Edison Company, always ready to submit and explain to the public its improvements upon many electrical devices, will of course be in the field, and promise a show which will only be rivaled perhaps by the United States Illuminating Company (Weston's system). The number of arc-light systems will be shown by 11, and the modes of incandescent lighting by 13 companies.

Quite a number of telephone companies have applied for space, but the American Bell will take the lead in display. The progress in telegraphy will be shown from the oldest Morse system to Delano's synchronous multiplex, and will prove interesting to students in that branch. Electric clocks, coming into common use now, will, of course, receive great attention. The Time Clock Company, the Kettel Clock Regulating Company, and Mr. Louis H. Spellier, the inventor of the celebrated Spellier system, will each illustrate their claims to preference at the exhibition, while the different watchman's time detectors will be examined with interest by the owners of large mills and stores. Several fire-alarm telegraphs are entered, and will make a good showing. Among these we find the famous Martin fire alarm, which, we understand, is now to be put into Jordan, Marsh & Co.'s extensive stores.

The greatest novelty in burglar alarms is the "electric mat," which can he hid under the carpet, and will ring continually, if once stepped upon by any intruder. The simplicity of the device will probably rapidly gain in public favor. Electric motors will be shown in great variety, from Edison's "Jumbo" down to the Reckenzaun motor, which is stated to weigh only 106 pounds, and the power of which is to be about 1½-horse. The so-called Cleveland motor of the Development Company will probably run a number of machines requiring small power. But there are certainly two exhibits that every one will feel a desire to see. One is the Bidwell electric railway, which will be run around the balcony on a track 600 feet long. The Bidwell railway is a departure from all other roads ever exhibited. The rails are not the conductors, as on other roads, but the conductors are tubes split longitudinally, and held in position, slit downward, by insulated supports from the side of the track. The dynamo and motor used will be furnished by the New England Weston Company, and the motor will be placed under the car, doing away entirely with the locomotive. Beside supplying the motor, the same current lights the car with incandescent lamps, and the street through which it travels with arc lights. The other exhibit we speak of is a miniature theatre, representing the cosey Bijou, of Boston, which was the first theatre in America lighted by electricity. Mr. Edison will supply the miniature electric lamps, while the Bell Telephone Company will connect this small playhouse with the Bijou Theatre on Washington street, and the visitor to the exhibition will be enabled at the exhibition building to listen to the melodies of the opera played at the theatre. We must say that the management has certainly done a great deal to attract the public, and we have no doubt the people will show their appreciation by a large attendance when the doors of this unique and entertaining exhibition will open to the public on Nov. 24. The exhibition is to be held in the Mechanics' building, which will allow of a good display of articles on exhibition. All inventors who have something new to show should embrace the opportunity to apply for space before the first of November, as that date is the last one for the consideration of applications.—*Boston Herald.*



WESTERN ELECTRIC CO.'S HOTEL FIRE-ALARM AND ROOM-CALL—FIGS. 1 AND 2.

The Edison Company's New Trustees.

The election of directors of the Edison Electric Light Company on the 28th was unexpectedly quiet. The ticket is as follows: E. D. Adams, J. H. Banker, C. H. Coster, Eugene Crowell, R. L. Cutting, Jr., Thomas A. Edison, W. L. Garrison, E. H. Johnson, F. R. Upton, J. Hood Wright, Erastus Wiman, Spencer Trask, and Charles Batchelor. Mr. S. B. Eaton said that a report of the finances of the company had been prepared, and would be sent to the stockholders during the week. Speaking of his own retirement from official connection with the company he said: "Mr. Edison has been for some time past dissatisfied with the direction and executive management of the company. He wished to make use of money to push the enterprise, but some of the directors, including myself, were opposed to employing it upon the terms offered, deeming it unadvisable on account of the dullness in business everywhere. This was the occasion of his making an appeal to the stockholders for proxies. When it became apparent that there were differences I said I would retire, and this was also agreed to by others of the directors with whom Mr. Edison was not satisfied. We were met by concessions on Mr. Edison's part, and the combination ticket which I then prepared was made up and elected." It is understood that active measures will now be taken to push the enterprise.

WAGES IN GERMANY.—A paragraph now going the rounds of the papers says that Germany is agitated by the question of women's wages. Female telegraphers work for $20 a month, a sum at which men refuse to engage themselves, and they are required to work not only more hours a day, but to take the place of those who are away for vacations.

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UNSOLICITED COMPLIMENTS.

While the Exhibition was open at Philadelphia, one of the visitors came to the exhibit of this paper, and asked for a complete set of back numbers. On being informed that the earlier numbers were unfortunately almost all out of print and that we could not furnish complete sets, he offered $50 for volumes 1 and 2, lying bound on the table of the exhibit. He was greatly disappointed when told that we could not part with the book.

This week we have received from a well-known medical man in Philadelphia a letter in which he says: "A scientific friend of mine in London writes me to send him 'a report or description' of the recent electrical exhibition in Philadelphia, and on addressing Prof. Geo. F. Barker on the subject, he replies that the best account he has seen of the exhibition is contained in THE ELECTRICAL WORLD of New York."

These two incidents speak for themselves, and the entire voluntariness with which the compliments have been paid to this paper warrants us in giving them prominence.

POT CALLING KETTLE BLACK.

It is remarkable with what avidity an accident in connection with electric lighting is seized upon by the enemies, open and overt, of the new means of illumination. A few weeks ago, an oiler of dynamos at the Health Exhibition in London, in spite of repeated warnings, placed his hands on one of the machines of high electro-motive force, and his death was the penalty. Immediately there was a hue and cry, and without waiting for the facts to come out, without making any distinction between machines of high E. M. F. and low E. M. F., ignorant men and prejudiced men burst forth into a denunciation and depreciation of electric lighting. The London *Electrician* of Oct. 11 says, gravely: "It is generally feared that the fatal accident at South Kensington, reported in our last week's issue, may seriously affect the interests of electric lighting at this crisis in its history. These apprehensions will of course disappear in due course, as all such apprehensions do; but our first impressions naturally are that the killing of a presumably skilled workman at an exhibition devoted to the preservation of health and life is a most unfortunate business, discreditable to those responsible for the disaster, and a discouragement to the employment of powerful dynamos for any purposes whatsoever. Further reflection will, to be sure, restore confidence both to the public and the profession."

The gravity of the situation may be all that is depicted, although we have our doubts about that. The case appears to be pretty much one of pot calling kettle black, it being now generally recognized that the incandescent light is coming more and more into use for domestic illumination, and is therefore to have its advantages belittled and its imaginary disadvantages exaggerated. Of course, there have not been wanting defenders of it. Mr. R. E. Crompton, in writing to the London *Times*, says: "The electric light has had a hard battle to fight, and this bugbear of the supposed danger to life has not been one of the least of its enemies. So long as currents of low electrical pressure, such as are used with incandescent lamps pass through the wires, they may be safely touched with one or both hands by a young child or delicate person with absolute impunity and with no disagreeable sensation beyond a slight pricking if the hands are damp. These facts are, of course, well known to the scientific world, but to the untrained public there is only 'one kind of electricity,' and they cannot readily understand why it should be dangerous to life in one form and not in another." Mr. S. F. Page, Secretary of the Edison and Swan Company in London, calls the attention of the public, through the *Daily Chronicle*, to the fact that the Edison dynamos do not generate a current of sufficient electrical tension to be in any way dangerous to life and limb; and at Manchester Mr. G. Freemantle, the Secretary of the Manchester and District Edison Company explains the whole matter very tersely, for public information, in the local *Courier*. We note, however, that all three gentlemen miss making the point that accidents of the kind are so rare that when one does happen it creates a downright sensation; whereas, accidents in using gas are so common and so much a matter of every-day experience that they now fail, even when serious, to excite comment.

Another point is, that while the dynamos for incandescent lighting are perfectly safe for household purposes, the dynamos for arc lighting are exactly those with which the individuals composing the public do not come in direct contact, any more than they do with gas works or gas engines, or locomotives, or steamboat engines. It is urged that, as the public does not know of the difference, the danger is not diminished but increased, but it seems to us that this is like saying that as some medicines or stimulants are dangerous, but the dangerous ones cannot always be distinguished from the innocuous, at a glance, all medicines or stimulants become dangerous, and should be let alone.

TELEGRAPHY AND TELEPHONY IN THE CONFERENCE.

The portion of the proceedings of the Conference published by us to-day deals largely with telegraphic and telephonic questions of the present time, and is in regard to telephony not less interesting and important than were respectively the portions relating to the theory of the dynamo-electric machine and the development of secondary batteries. Mr. T. D. Lockwood's able, thoughtful and practical paper deserves careful reading by every telephonist in the country, while the points touched upon by Mr. W. H. Preece, Prof. Rowland and Mr. Koyle are also worthy of more than ordinary consideration. The cuts will be found to assist materially in an intelligent comprehension of the various points raised. As a review of what has been, and is being, done to perfect telephonic communication and increase the usefulness of the invention, the discussion in the Conference is notable and welcome.

ELECTRIC LIGHT HYGIENE.

At the Congress meeting of the Sanitary Institute of Great Britain, held in Dublin last month, Mr. J. A. Fahie read a good paper on electric lighting from the sanitary point of view. One instance, taken from his own experience, of the hygienic advantages of electric illumination, is very striking. He has had charge for the past nine months of an installation in the office of the *Irish Times*. The composing room is a large apartment, 60 × 40 feet, and 70 feet in height. It was formerly lighted by 100 gas jets, the temperature frequently ran as high as 85° in winter and 95° in summer, and the compositors suffered greatly from discomfort and ill-health. Since the introduction of the electric light, a material change has been effected in the condition of things. The thermometer has marked several degrees below its former range when gas was used, the light is steady, bright and cheerful, and although many of the men work longer hours than formerly the sick list has all but disappeared. Still, there is nothing wonderful about this when it is borne in mind that a common gas jet vitiates as much air as four or five persons, and that, as we have more than once shown, the electric light of either kind neither consumes oxygen nor produces carbonic acid gas.

PROMETHEUS UNBOUND.

The dissensions in the Edison Electric Light Company have at last terminated in a victory for Mr. Edison in the election of a Board of Trustees satisfactory to himself and his immediate associates. It has been known for some time past that there were two parties in the management of the affairs—the one slow and conservative, the other, including the great inventor, active, energetic, and willing to spend money for the sake of making money; and apparently the slow element had the ascendancy. The result has been, as Mr. Edison himself put it, that his work has languished for lack of proper pushing, and his light has not been used on anything like the scale that he might reasonably expect. There would be little exaggeration in saying that the Edison Company ought to occupy to-day almost as commanding a position as that enjoyed by the American Bell Company, and the reason for the comparative want of success can only be found in the lack of enterprise and push on the part of the old Board of Trustees.

But Prometheus has now been unbound, and is at liberty to offer his fire with all its advantages to the humblest in the land. We look with confidence for radical changes in the policy of the company under the new management, and offer Mr. Edison our congratulations upon the good results of his first move.

The Progress of Electric Lighting in England.

In a recent editorial article on electric lighting in England, in this paper, the remark was made that while the history of electric light companies there was one chiefly of disaster and failure, private firms appeared to be doing meanwhile a very large and profitable business. In point of fact electric lighting has made vast strides in England, as in other parts of the world, during the last five years, when it may be said to have practically commenced. The first exhibition of any note in England was that at the Royal Albert Hall, which was closely followed by a semi-exhibition at the Conversazione of the Civil Engineers' Institution. The principal arc lights at that time were the Jablochkoff, Wilde and Siemens. There were, however, other lights shown, such as the Werdermann, etc., which have since come into prominence. The only lamps shown of an incandescent type were lamps burning in the open air, with a filament of an alloy of iridium. These were shown by Mr. Sellon and Mr. Henry Edmunds, afterward severally connected with the Brush and Swan companies. The only electric lighting companies of any prominence then existing were Messrs. Siemens Bros., the Electric Lighting Co.. working the Wilde system, and the British Electric Light Co., who were pushing the Gramme machine. There were also one or two firms scattered about the country at work, but they made no specialty of electric lighting. Practically the first start given to electric lighting was gained from the introduction of the Brush system, the success of which was chiefly due to the use of high tension direct currents working a large number of lamps. It was also due to the very energetic manner in which it was brought forward, and to the high qualities of the Brush dynamo machine. The lighting of London by various companies and the exhibition at the Crystal Palace were the forerunners of the floating of several parent companies and a very large number of subsidiary companies, the details of which are well known. The less said about them the better. We may state, however, that these, with few exceptions, have altogether failed, the parent companies which promoted them having sunk extremely in public estimation and lost a very large portion of their business and capital.

The firms and private companies which did not enter at all upon this speculation have on the contrary done well. Among these may be mentioned Messrs. Siemens & Co., Messrs. Crompton & Co., and Messrs. Woodhouse & Rawson, these three being a long way the most eminent of the electric lighting firms. There are also in several of the larger towns private firms and companies who are doing a sound business. Of the parent public companies the only ones that are practically in existence are the Brush Co., the Edison-Swan Co., and the Hammond Co.—the Pilsen & Gulcher Co.'s, perhaps, being also included. With regard to the three private firms, it may be said that Messrs. Siemens & Co., are doing a steady business, although they have to a certain extent given up the lead that they once held in the electric lighting world, having ceased to make the specialty of it that they once did. Their machines, nevertheless, still bear the same high character. Messrs. Crompton & Co., have made a specialty of the manufacture of the Burgin machine, which has been greatly improved by the exertions of Mr. Kapp, their works manager, and is now considered to be one of the best English machines. They also have considerably improved their arc lamp, which is now known as the Crompton-Crabbe. Messrs. Woodhouse & Rawson seem to have made greater progress than the other firms in England, although their business was only established in a small way about three years ago. They have three separate departments, viz., manufacturing, supply and contract. In the former they manufacture incandescent lamps, switches, instrument gas lighters and similar apparatus. They are also coverers of wire and manufacturers of nearly every kind of plant used in electric lighting. Their supply department is practically a merchants' business, as they buy and sell in all parts of the world, having established agents and offices. In their contract department they fit up installations in the same manner as the stock companies. They are best known for their incandescent lamp, which, according to the authority of some of the leading English electricians, takes under 2½ Watts per candle power. We learn that their recent contracts include one for over 600 lights and twice that power, for the London Stock Exchange. They have also put in two installations of over 600 lights each for the Lancashire & Yorkshire Railway, and are lighting up Messrs. Guinness' Brewery, at Dublin.

National Conference of Electricians.

FIFTH DAY—SEPT. 12, 1884, 3 P. M.

The President: Prof. Abbe is present and I will call upon him for a report of his Committee.

Prof. Abbe then read the first preliminary report of the Committee on Atmospheric Electricity.

FIRST PRELIMINARY REPORT OF THE COMMITTEE ON ATMOSPHERIC ELECTRICITY.

The Committee recommend to the National Conference and the United States Commission, that the Government be urged to take steps to secure on a large scale observations of Atmospheric Electricity and strength of Earth Currents.

That the methods of observation and report conform as far as possible to those about to be disseminated by the International Bureau of Telegraphic administration at Berne.

That the Government appoint a permanent Committee of Five Electricians to co-operate with the Chief Signal Officer of the Army in organizing this service.

That this Committee include, among others, the Electricians of the Western Union Telegraph Company, the Bell Telephone Co., and others of wide experience.

The next meeting of your Committee will be held October 1st and 2d, at Baltimore immediately after the conclusion of Sir Wm. Thomson's first lecture, by which time further details will have been elaborated.

Cleveland Abbe, Francis E. Nipher, W. H. Preece, James Allen.

The President: The next subject is Induction in Telephone Wires, Long Distance Telephoning, and Underground Wires. I call upon Mr. Lockwood to state some of the principal facts with respect to induction on telephone wires and its difficulties.

Mr. Lockwood: Mr. President and Gentlemen—I find that the subject on the programme is entitled "Induction on Telephone Wires, Long Distance Telephoning, and Underground Wires," a title that is very comprehensive and that is somewhat misleading, because from actual experience I have found but very few of the disturbances which we meet with on telephone lines are, in fact, due to induction. A better title is:—

On the Electrical Disturbances Occurring in Telephonic Circuits and the Methods Proposed for Obviating or Overcoming them.

Twenty years since when electricity was a mere branch of physical science, it was easy for the student, the professional man, or the engineer, to keep pace with its advances in every direction; for the ramifications of applied electrical science were few in number, and comparatively simple in character.

When we have referred to the telegraph in its several forms, to electrolysis in its applications to electrotyping and plating, and to the miscellaneous practical operations of gas-lighting, burglar and fire alarms, and to electro-therapeutics, we have substantially scanned the limits of the electrical field of that day.

At the present time, twenty years later, the domain of electricity has so wonderfully amplified, is even now so extensive, and is so rapidly enlarging its boundaries from day to day, that we cannot, and may not, dare to limit its possibilities, although we regretfully recognize the inevitable truth that it is no longer possible for a single mind to grasp fully, comprehensively, and, in detail the multitudinous forms, and the numerous subdivisions of the useful applications of electricity and magnetism.

Where, two decades since, one might by close attention, unremitting perseverance and natural ability view the entire department to which I have alluded, and, Selkirk-like, pronounce himself "monarch of all he surveyed," now he must aspire in vain to such an eminence; for where at that period we could utilize electricity in forty ways, we now enumerate four hundred applications of the same form of energy, without exhausting the list; and when the aspirant to universal and all-pervading knowledge views the vast circle of useful arts lying about his feet, each dependent in some way upon electricity or its affiliated forces, and each requiring almost the proverbial span of human life, threescore and ten years, for the acquisition of a perfect acquaintance with its workings, he may well stand aghast and confess that such a universal knowledge is now unattainable, and that if he achieves excellence in a few branches he may reasonably be satisfied with a more general and cursory acquaintance with the others. We often hear the expression, "Electricity is in its infancy," and it may be interesting to note that this phrase is not exclusively the sentiment of our own time or even of the nineteeth century. In a book which has recently come under my observation entitled "An Essay on Electricity," written by a Mr. George Adams, in 1792 (and proving conclusively in the estimation of the author that electricity is real and substantial matter), we find the same statement made in the following connection:

"As electricity is in its infancy, when considered as a science, its definitions and axioms cannot be stated with geometric accuracy."

The foregoing considerations have, in some measure, guided me in my choice of a subject, since I have reflected that only in a realm with which I have long been familiar can I hope to bring forward any thoughts which can in any degree interest such an assemblage as this. I apprehend that our present rapid advance in the utilization of electricity is due, to a considerable extent, to the more matured views which we now hold with respect to the character or nature of that mysterious and potent force.

For it is apparent that when by patient and diligent research we arrive at an intelligent comprehension of the nature of any force or element, we have made a long step towards realizing its capabilities; and when in accordance with modern teachings we assume that electricity in common with light and heat, is a form of molecular motion, we have a warrant for believing that, notwithstanding the tremendous strides which have been made in applying these forms of motion to the work of satisfying the wants of mankind during the past years, and the allegation of Mr. Adams ninety-two years since, electricity if not still "in its infancy," has certainly not passed the limits of childhood, and gives encouraging promise of a robust and well developed maturity.

It is worthy of remark that each fresh discovery and invention in the realm of electricity serves not merely its direct and obvious purpose, but also performs the equally important function of a finger-post or guide-board pointing to further discovery.

One of the earliest results of the invention of the telephone, the practical speaking telephone of to-day, was the discovery of the universality of extraneous and foreign electrical transfers; of currents passing constantly in ever-changing variety in electric lines of all descriptions. In other words, the telephone proved itself to be an electroscope of the most delicate nature, which acts, as it were, in the manner of a microscope upon lines of communication, ascertaining and proving the presence of numberless currents, too small and infinitesimal to materially interfere with the coarser and comparatively expressionless telegraph instrument, but of an electromotive force, volume and variety sufficient to act powerfully upon the sensitive articulating telephone and to affect considerably its successful working. I have not the slightest intention to argue the vexed question of the inventorship of the telephone, but I believe it due to myself to state that I hold it to be evidence of the strongest character that the various instruments, produced from time to time as alleged anticipations of the great discovery and invention of Alexander Graham Bell, are not truly and really electric-speaking telephones, except when used in the light of the present state of the art, in that they were not so far as we know troubled in their operations by induced or atmospheric electrical currents. Yet almost coeval with the first published results of the articulating telephone of Bell, we find ourselves confronted with complaints that the noises which were not wanted made it very difficult frequently to hear, and properly interpret the reproduced articulations which it was desired to hear. And almost immediately thereafter we find inventors racking their brains to invent remedies for these annoyances.

Some of the manifestations which have been experienced are most remarkable. It is scarcely necessary that I should attempt a detailed description of the various currents which surreptitiously introduce themselves into and haunt telephonic circuits, as every one here must have noticed them.

The following notes concerning the behavior of these currents have been gathered from experience.

Long telephone lines are much noisier than short ones.

Sometimes one end of a long line (say 200 miles) will be perfectly quiet, and the articulations transmitted from the distant station are reproduced with the most emphatic clearness; while at the same time the opposite end of the line is very noisy, and the attendant there finds the utmost difficulty in receiving the message by reason of the noise which drowns the articulation.

I have found as a general thing that lines running north and south are much more subject to disturbance than lines of equal length running east and west.

On the contrary, the individual line which has been most severely afflicted is a regular telephone line running east and west. This, however, is an iron wire of the large size of No. 4 B. W. C.

The sounds heard in a telephone on a noisy line, are much intensified at or about mid-day or midnight.

Lines constructed along the sea-coast are, as a rule, much less subject to disturbance by induction than those which are inland.

Lines constructed on high land, or in mountainous districts, are subject to periodical storms—that is, at certain hours each day the noises reach a maximum intensity.

A line constructed of large wire is invariably much more subject to inductive disturbance than a line of small wire of the same length and strung in the same location.

A line of comparatively low insulation is not so noisy as a well insulated line of the same length, size, and in the same location.

A line consisting of a continuous metallic circuit is almost as noisy as an earth circuit between the same points, except when the two wires of the circuit are parallel to one another, and equidistant from disturbing wires.

Now we know that the telephonic currents proper are very feeble. It is therefore evident that an instrument, such as a receiving telephone, which can be acted upon by such currents must be correspondingly delicate and sensitive; and it is the very sensibility which I have already referred to, and on which the legitimate action of the telephone is so dependent, which becomes under the pressure of the adverse influence of disturbing currents actually a detriment to the advantageous use of the instrument. It is simply this fact which has prevented any radical improvement from being made in the magnetic receiving telephone, for it is found that the capacity of the instrument to reproduce sounds, due to foreign and undesirable currents, increases in the same ratio as its capacity for reproducing the desired articulate sounds is improved.

It has, consequently, been found more profitable to direct our efforts to the improvement of the transmitter, whereby the telephonic current can be made more powerful and enabled to override the obstacles in its path.

If we attempt to classify the different disturbing sounds heard in the telephone, we find that they may be arranged as follows:

First—Frying, hissing and whistling noises.

Second—Loud screaming and whistling noises.

Third—Jerking and rasping noises occurring occasionally.

Fourth—Telegraphic signals in course of transmission over other wires.

Fifth—Telephonic messages from other wires.

We may hear the first-mentioned sounds on almost any telephone and at almost any time, their energy, however, varying with the length of the line and the time of the day. The sounds of the second class are chiefly heard about midnight and noon. I conceive that sounds of both classes are almost entirely due to the presence of earth currents, atmospheric electricity, and thermo-electric currents. Earth currents we find most frequently to affect lines running northwest and southeast.

The free electricity in the clouds and air also appears to act inductively upon the wires (these being of course in contact with the earth), and produce a continuous series of small discharges, which manifest themselves by crepitating sounds in the telephone. I have sometimes listened all night at the telephone, and find all of the above noises to be more intense by night than by day, the disturbances of the second class, *i. e.*, the screaming and whistling noises becoming especially emphasized about twelve, midnight.

The thermo-electric currents I have mentioned seem to be developed by the varying temperature of the wire with respect to the earth, the said temperature being usually greater than that of the earth during the day, and less during the night.

If this supposition be based on fact, no line in which the earth forms a part of the circuit can be totally free from these disturbing influences; even if a complete metallic return be used, there will be at each point of support a leak to earth, albeit a leak of high resistance. A parallel metallic return is therefore not an absolute guard for these currents. The French philosopher, M. Gaiffe, has devoted much time to studying the various causes of these disturbances, and in addition to those I have named he puts forward the statement that "every change in the position of every wire relatively to that of other wires on the same supports causes magneto-electric currents in the others."

This position is I think uncontrovertible and my own observations lead me to make the following addition thereto: "That when wires are suspended in a direction at an angle with the magnetic meridian, magneto-electric currents are developed in them with every lateral movement or swing which they make."

Referring to the third class of interfering sounds—jerking and rasping, but isolated noises—they may be attributed to mechanical defects of the circuit, such as imperfect joints and loose connections. Such imperfect contacts set up microphonic action with its resultant sounds.

Since the remedy for this class of faults is so evident I may as well advert to it now and dismiss it from our future consideration.

It is obvious that more care in making joints, splices and screw connections and a judicious use of the soldering iron, would effectually cure this disease.

We arrive at length at the disturbances which constitute the worst enemy of the telephone, viz., those which I have arranged in classes 4 and 5. Their perniciousness arises not so much from their loudness or intensity as from the fact that they infest short wires as well as long ones.

These are readily ascribed with certainty to a variety of causes, the principal of which are:

Leakage of electricity from other wires.

Electro-dynamic and electro-static induction, and in the case of the 5th class, especially to the surcharging of small and inefficient earth terminals.

The first cause, leakage, is, as we are well aware, not exclusively confined to telephone lines, but has affected telegraph lines from the earliest times of telegraphy. Imperfect insulation allows the current to divide itself between all the wires on the support, in the ratio of their respective conductivities, and, as the shorter the wire the higher the conductivity, the tendency is generally to escape from a long circuit into a short one.

When the current escapes to the earth no great harm is done, as the only effect is to weaken the signals; but when it leaks into another wire it confuses the signals on the second line.

Dynamic or current induction also produces results, so far as the telephone is concerned of the same general character, so that if the telephone line runs parallel to a telegraph line for some distance, the signals of the latter are perfectly reproduced in the former. I have myself repeatedly read off Morse signals in a telephone connected with a wire stretched adjacent to the Morse line. Worse yet is the induction between telephone wires, by which words spoken into the telephone on one line can be heard with equal facility in the telephones of other lines running in parallel proximity to the first. Electro-static induction, in addition to its retarding and prolonging results, which I shall have occasion to refer to hereafter, also exercises the repeating effect which I have described as accruing from current induction.

All of the disturbing agencies which I have noted may be observed in comparatively short lines. I have noticed them in lines of not over a quarter of a mile in length, but when a circuit is many miles long, their operation is naturally greatly accentuated.

We may now consider the various means which have been proposed or used for the diminution of these vexatious parasites of electro-telephonic communication. As I have indicated, the necessity of some remedy was seen as soon as the telephone was used. Mr. W. H. Preece long since pointed out that three ways of attacking the enemy presented themselves.

1. By increasing the intensity of the transmitted currents, so as to make them decidedly stronger than the inimical currents, and also to reduce the sensitiveness of the receiving telephone.

2. To place the telephone wire beyond the range of induction.

3. To neutralize or compensate the effects of induction.

But these methods all assume that the disturbances are due exclusively to induction, which we can by no means allow.

I believe that to intelligibly apply a remedy it is requisite that we should first be sure of the disease. The three hints are, however, good as far as they go especially if we use them collectively. We comply with the first by using the various battery transmitters, and microphonic speakers; while in receivers, the static telephone of Prof. Dolbear affords a good instance of what has been and may be done in this direction.

The second method is incomplete, since it deals with induction only.

The third is the most promising. The earliest remedy suggesting itself to those who were interested in the subject was the most natural one, viz.: the use of a metallic return wire. It is, however, a condition of success, that the two wires must be parallel to one another, and so placed as to be subject alike to the disturbing influence. As this device was the first, it is also the most effectual, and is the only one which seems to attack and reduce the vigor of all the opposing agencies. It weakens the earth currents—as the only connection of the circuit with the earth is through the high resistance route of the poles. It diminishes leakage for the same reason. It opposes induction by receiving the induced impulses in both directions at once, and the induced current, like a two-headed snake swallowing itself, is neutralized by its own energy, and the effects of static induction are reduced, or at all events they are noticed less, because the wire is otherwise comparatively clear and quiet. I would not be understood as making the statement that the use of the parallel metallic circuit for the neutralization of induced currents is a novel idea. On the contrary, it is a very old laboratory contrivance for the same purpose, and was patented as a remedy for static induction at a very early date in England by Dr. Werner Siemens. The application to telephony, however, is a new one, and has again brought it to the front.

Another device, tending to the neutralization of induction between any two circuits, was to provide a double-wound induction coil, and to pass the two circuits through the said coil reversely with respect to one another; as this

the currents induced by one upon the other, on the line, would be neutralized by the same forces exercised oppositely in the induction coil. While in a measure successful, this expedient is not practical for several reasons. When more than two lines are involved, the apparatus soon becomes cumbrous. The resistance of the coil portion of each circuit is a dead weight upon the working of the line.

It was at this time ascertained by experiment that a multiplicity of telephone wires running together was actually an advantage. It was found, for example, that although when there were but two or three wires the interference was quite pronounced, the increase in the number of the wires greatly reduced the virulence of the trouble. The disturbing currents seemed to divide among the circuits, thus helping each one. This, of course, is in accordance with the law of derived circuits, and is the fact which has made the telephone exchange possible. It seems, however, to apply only to short wires. Subsequently, it was assumed that the great part of the objectionable noises arose from actual leakage alone, and that induction or earth currents had little to do with it. Acting on this presumption, it was proposed to provide each insulator pin with a metal socket fitting in the cross-arm, to unite all the sockets on a pole by wire, and to connect them all with an uninsulated wire running from pole to pole, this wire in turn being united as frequently as was thought necessary with ground or earth wires leading down the poles. This also was an old idea, having been originally devised and patented in England by Edward Highton, and applied there to the telegraph poles from that time until now for the purpose of conducting leakage to earth. And this remedy indeed does reduce the total disturbances very considerably, inasmuch as it carries off the actual leakage. It is by no means a perfect remedy, and, in my opinion, by no means an unobjectionable one, since not only does it grapple only with such disturbing currents as have actually leaked by conduction from wires, but it also greatly enlarges the electrostatic capacity of the lines, since it brings the earth virtually into close proximity to the lines, thus introducing the retardation or sluggishness and prolongation which always is the attendant of static induction, and produces indistinct articulation.

I assisted in the year 1880 in fitting a forty-four mile line between Boston and Providence with these contact conductors, and when finished, although the line was not very noisy, the retardation was quite perceptible and caused a kind of echo to the reproduced sounds, at the time affecting the clearness of enunciation.

We then attempted to lessen this by placing at intervals of a few miles high resistance leaks to earth. This worked a short time and reduced the capacity, but it was found difficult to maintain a constant resistance in the leaks, and ultimately the lines were coupled up as metallic circuits, and in that arrangement gave entire satisfaction. It is, I think, unwise to attempt to diminish leakage on pole lines in any way except by improving insulation, and even then it seems desirable to keep the static capacity of the line as low as possible. In fact one of the patented devices for reducing induction is to place at suitable distances from one another along the line a leak to earth, by omitting perhaps one insulator per mile, and fastening the line wire instead to an iron cap which incloses but does not touch the terminal of an earth wire.

In 1879 compound conductor cables for aerial work were introduced, to reduce induction between the wires. Each insulated conductor was sheathed in metal foil according to the patent of Dr. Foucault, the foil being connected by wire with the earth. This expedient also proved effectual, and has till the present time remained in use. In using this expedient, it is assumed that the insulation of each conductor is good, so that leakage may be eliminated from the list of opposing agencies. It is evident that the arrangement acts as a screen against induced currents between wire and wire, acting thus as a preventive of interference from such currents, while it simultaneously weakens the intensity of the sounds due to earth currents by increasing the capacity of each wire. This, however, is effected at the expense, as in the pole lines, of distinct articulation, inasmuch as retardation is quite pronounced when the cables are more than a couple of miles long.

Such success as this device attained has brought forward a host of imitators; among others, a modification of this device has been introduced by Mr. David Brooks, Jr., of Philadelphia, in which two separate insulated wires were used for each circuit, one of the wires being included in the circuit, while the other was connected to earth.

A cable of solenoid form has also been proposed and patented by Prof. Orazio Lugo, but it is of course only a variety of metallic circuit, having the leading out and return wire twisted together. These methods are all helps for short distances, but when long lines are required, one consideration or another opposes their use. The worst feature about the earth connected metallic sheath is the ensuing retardation, and experience has demonstrated that a cable of twelve miles in length so protected, is almost impassable to the electrical changes necessary to articulation.

I may also note that isolating the line from the earth altogether by means of condensers has from time to time been tried, and while it is to a great extent efficacious against the earth current annoyances, it does not seriously affect induction, inasmuch as, although there is no continuous circuit, there is ample conducting area and surface for the variation in charge.

The condensers also are very liable to be destroyed by lightning.

Van Rysselberghe, of Belgium, some two years since made experiments tending, among other results, to the freeing of the telephone lines from telegraphic induction. His plan was chiefly to so arrange the sending key of the telegraph system that it would, when operated gradually, introduce resistance into the line instead of altogether breaking the circuit, the theory being that the induction was caused by the suddenness and intensity of the variation in the telegraphic circuit.

There are two practical disadvantages in this arrangement, the first being, that as a preliminary step it is requisite that both telegraph and telephone wires should be under the same control; a condition which rarely occurs; second, that so arranging the key cripples the efficiency of the telegraphic service, as it would greatly decrease the speed of operation.

Within the last two years the construction of the compound wire of the Postal Telegraph Co. between New York and Chicago marks a new era in telephony. It was ascertained, by actual experiment with that wire, that long-distance talking could be achieved with a conductor of sufficiently low resistance. It was at times a noisy wire, while at other times it was remarkably silent. But the success with which conversation was carried on over it showed that high conductivity was the principal condition, and that it was also a desideratum to combine if possible the requisite degree of conductivity with small surface, so that the electrostatic capacity should be low. These conditions led the American Bell Telephone Co. to fix upon hard drawn copper wire as being the wire most suitable for long lines; by its use a high degree of conductivity was gained, while the size was not enlarged, as would be the case if the same conductivity were sought in an iron wire. Heretofore copper had not been manufactured in a suitable way for this use, but at this time a good article of great strength had found its way into the market, and the American Bell Telephone Co. built a double line between New York and Boston of No. 12 Birmingham wire-gauge hard copper. The line when erected was found to be an easy working one, but when either of the wires was used singly, considerable noise, due to earth and atmospheric currents, appeared, making the conversation weak and hard to understand. The line has therefore always been worked as a complete wire circuit, and in that condition works quietly, clearly and perfectly. We are thus brought back to the original remedy for the disturbing influences of telephone lines. It is the only remedy which has proved to be at all times efficacious, and we are forced to the conclusion that with our present knowledge it is our best resource.

It may be interesting to state that when this double line was working perfectly between the two terminal stations, no sound being heard except the telephonic reproductions, should a way or intermediate station introduce its telephones and apparatus into one of the wires, so as to constitute a half-way station on one side only of the metallic circuit, noise at once appeared in the telephones at each station, the balance being evidently lost.

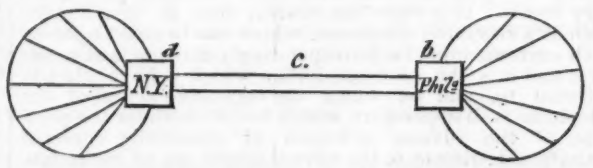
The features which oppose the use of the double circuit expedient are obvious to every one; they are the double expense of material and construction, and the difficulty of working it in connection with single earth circuits such as the great majority of our telephone lines are at the present time.

The former difficulty is of course insuperable, and will have to be borne; but it is probable that for such persons as desire to communicate frequently between cities at long distances from one another, loop lines will be built, adapted to form extensions of the trunk metallic circuits.

Thus it appears that while many devices have from time to time been proposed and explained, scarcely one is suitable for lines of all lengths, or is efficacious against all the forms of adverse currents.

In conclusion, we have apparently much reason to be encouraged to believe that in the early future, by carrying out only first-class construction, using conductors of high conductivity and low capacity (and we are aided in this by the knowledge that electro-static capacity increases, all things being equal, as the conducting surfaces, which only doubles with the doubling of the diameter of the wire, whereas the conductivity is quadrupled when the diameter is doubled), making only perfect splices and joints, uniformly soldered; better and larger ground terminals and improved switch-board contacts; employing powerful transmitters; utilizing metallic circuits for distances of over one hundred miles, and exercising judgment in proportionment of induction coils to line, we may be able to communicate telephonically over distances which only a short time since seemed incredible.

In the matter of metallic circuits between different centres of telephonic communication, I would like to illustrate upon the black-board an invention which seems to me to be of some interest.



Here is Philadelphia, and here is New York; here are the central offices (*a* and *b*), at which place a number of lines radiate to subscribers' residences, with a double wire (*c*) between the stations. It is obvious that connecting a single wire to the double circuit is of no advantage; it is simply making the conductor twice the size. We have grappled with some interest that problem how to effect the connection of two lines, giving the short line all the advantages of a large metallic circuit without running the two lines for each wire. We have done it this way: we have run a wire around from the central station to as many places as desire to use the metallic circuit. If the subscriber wishes to use the call-box, by turning the button one way he can talk out of town, and turning the other way he can talk in town. But this method, if it be adopted, will necessitate the use of two telephones, which may be hung on the call box.

The subscriber will understand that if he talks by the right-hand telephone he will be talking to people in town, and if he talks by the left-hand telephone he will be talking to those out of town.

There is but one more point I would like to refer to; and I will be extremely brief. And that is, in the present stage of electrical communication, whether it be telegraphic or telephonic, the country seems to be very anxious to bury us underground. It is perhaps of some interest for us to know how far we can work underground. There is no doubt but different systems of telegraphy, especially those which are not particularly fast, can be worked for a reasonably long distance, certainly for cities, below the surface of the earth. In Boston, we have a large system of telephone wires laid in tubes between vaults at street corners. When working them between two subscribers in the city they work fairly well, but not so well as those overhead.

We have found that when we connected a short wire, of say half a mile underground, with a long wire, say about 30 miles, leading out of the city, we have difficulty. The subscriber at the end of the short wire can make himself heard at the end of the long to the distance of 30 miles; but the subscriber at the end of the long wire is not in so fortunate a condition, and cannot make his friend hear him at all. I think the same trouble has been met in England, in automatic Wheatstone lines. The subscriber at the end of the short line seems to be favored by the long line to a more even distribution.

We went out to Pittsburgh some few months ago to see an underground cable, I believe 8 miles long, and it really worked very well through the 8 miles; but on connecting the line to Wheeling, 90 miles distant, although Wheeling could hear me first rate, I could not tell there was any one talking there.

Mr. Preece: Mr. President, I feel sorry that you should call upon me, who have already taken so much of your time to-day; but I am bound to confess, in the first instance, that I regret very much to find that you have not in this country that advantage which we have in ours, namely, a society meeting very frequently where novel ideas are discussed, and where there is a free circulation of notions on work done in different parts of the country.

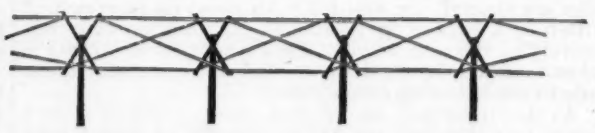
Mr. Lockwood commences his paper by saying that it was one of his duties to find out what has been done in these questions in other parts of the world, and I am bound to say that I think he must have neglected his duty, inasmuch as he failed to bring before you anything, as far as I can remember, of what has been done in England in curing the very defects to which he has alluded. Of course in England we are very much behind the world in a great many things. We are certainly behind the world in the practical application of call-signals and of telephones for the general transaction of business in large cities. I do not know why it is so. I suppose it is the phlegmatic habit of the country; but there is certainly some very strong reason why the telephone has not been adopted to the same extent that it is here. But if we are backward in the commercial use of telephones we certainly are not backward in the scientific application, and in the applications of means to the discovery of the causes of defects in working, and in devising means to cure those defects.

If you had a society such as I speak of, I think it is highly probable the occasional papers that are read in our English societies would find some circulation here; and certainly a paper that I read in the year 1878, before the Physical Society in London, and a paper which was read by Prof. Hughes before the Society of Telegraphic Engineers in London, and discussions that have taken place at those two societies, as well as discussions that took place before the Paris Congress, must have reached here, and must have received some attention from you.

Now, in the first place, I may say that I perfectly agree with Mr. Lockwood that too much attention has been given to induction as a cause of disturbances. Induction is not always the cause of disturbances. The disturbances are attributable to other causes such as he enumerated. Let us take one or two of them, not in the order he gave them but just in the order that they struck me as he referred to them.

In the first place, as to the difference in the disturbances due to the geographical direction of the line; they have been observed in England, and I, like Mr. Lockwood, have spent nights in listening to these various sounds; and peculiar sounds they are. The idea they conveyed when I heard them was rather that of the whistling of young birds in their nests. I do not know why I should think that of such sounds; but while holding the telephone to the ear, the curious whistling noises they made sounded very much like young birds in their nests; and I think the cause is very obvious; it has been mentioned by Mr. Lockwood. It is due to the swinging of the wires across the lines of force of the earth's magnetism. It is very easy to comprehend that if a wire swings at right angles to a line of force a current will be induced; and when you have one or two hundred miles of line with some twenty or thirty sags to the mile, there will be periodic swingings that will produce musical notes and these different sounds.

The very first telephone that was taken to England was taken over by myself. When I was visiting this country seven years ago, in 1877 I think it was, Prof. Bell presented me with two telephones. I took them over to England, and appeared before the British Association, then meeting at Plymouth, and there we spoke between Plymouth and London. The very first telephone circuit that was put up in England was a metallic circuit put up by me, especially to cure this disturbance to which we have alluded. Although Mr. Lockwood, in his remarks, has spoken of a metallic circuit as being a cure for these disturbances, he has not hit the right nail upon the head, according to my belief; and that is that the metallic circuit cure is not so much due, *per se*, to the metallic circuit as to the fact that this circuit is made to pass round itself. When we put up this metallic circuit the two wires constituting a circuit rotate round each other at every four poles. When we put up four wires we put them up in this way:



If you could fix your eye at one end you would find the wires numbered in order 1, 2, 3 and 4 upon the four posts, as follows:

1	2	4	1	3	4	2	3
4	3	3	2	2	1	1	4

1 and 4 form one circuit and 3 and 2 the other. These four wires are constantly revolving around each other, the two wires always keeping the diagonal position. The object of that is that, however many wires there may be on these poles—in many instances as many as twenty, thirty and forty wires—the mean distance of each telephone circuit from the mean resultant wires of the other working circuits is always the same, so that you have a constant equalization of the influence of one wire upon the other. That principle is carried out to a very large extent between Liverpool and Manchester, between Glasgow and Edinburgh, between London and Liverpool, and between London and Manchester. And in future all the lines in the country will sooner or later be connected in this way.

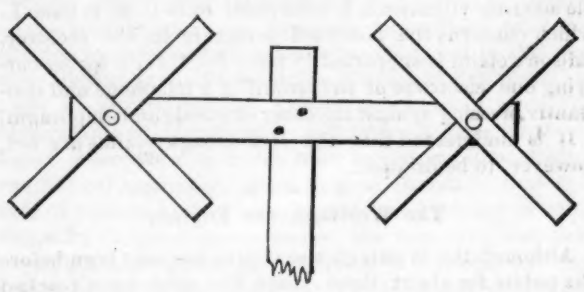
The average number of wires on the poles is something like fifteen, and these are on the same poles which carry telegraphic wires. There is a modification of this plan being carried out; we are doing it in this way (See cut, top of page 171).

So that the same arm which carries two telegraph wires will carry eight telephone circuits.

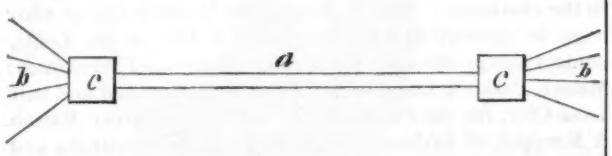
The wire used now almost universally for telephone and telegraph purposes in England is copper wire. The days of iron wire in England for these purposes are practically

numbered. The copper supplied to us is of the strength of steel. It cheapens the construction of telephone and telegraph lines and is a very great advance. I believe you are also carrying it out to a considerable extent here. It is called hard drawn copper wire—pure 98 per cent. copper.

I wanted to point out that there are two main features in this circuit; one is the total elimination of the influence



of the earth and the other is the total removal of the inductive effect between one wire and another. We have in the use of the earth a far more serious difficulty than Mr. Lockwood mentioned, and that is bad earths. It is astonishing when you come to measure the resistance of the earth for telegraphic and telephonic purposes and for lighting what a tremendous resistance these earth-plates make. I asked one of the most distinguished electricians in France, M. Lavier, what allowance he made for the resistance of earth-plates; what he considered a good earth-plate; and what he supposed was a bad earth-plate. He replied that he was quite satisfied if his earth-plate gave a resistance of 25 ohms. Now we have considered that an earth-plate should give no resistance at all. Although I have measured a good many earth-plates, I have never yet succeeded in finding one that did not give any resistance. It is the resistance of these earths, so often carelessly made—perhaps a wire whipped around the gas pipe, or a water pipe, so frequently used in renters' offices—that has, I believe, caused as much disturbance as any other. Mr. Lockwood has an ingenious plan, a new one, by which a single-wire system can be worked, and which dispenses with the double-wire metallic system; but we have another plan in use in England, between Edinburgh and Glasgow and between London and Manchester, and that is the use of induction coils.



Here (*a*) is a double wire and here (*b*) are single wires, and here (*c*) an induction coil. The double wire is in the secondary wire of that induction coil. The subscriber is in the primary circuit of the induction coil, and if a subscriber wants to communicate with another subscriber he speaks through the primary wire and induction sends a current through this line wire to the receiver. It is a very ingenious system to work a single wire instead of a double set of wires, and it is very efficient. I do not think it is so good as the plan described by Mr. Lockwood, because it introduces two additional induction coils which are always a source of serious trouble. He referred to the system of Van Rysselberghe that has been tried. But it is one of those things, like many other systems of the kind, that have been burst up on our side of the water. There is nothing in it.

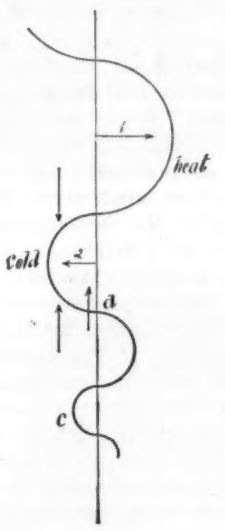
There is a plan I would like to point out by which the disturbance of the intermediate stations may be somewhat obviated. If we want to put in an intermediate system, for instance, if you wanted to put in a way station, most people would be inclined to put it in on one wire; but when we do so—I dare say you do the same thing here—we always bridge it across between these two wires (indicating). We put it in as a bridge so that it does not disturb the balance.

The last point I would bring before you is what Prof. Rowland adverted to (relating to the paper that was read by Lord Rayleigh at Montreal). Lord Rayleigh produced a formula giving the conditions for determining the distance through which you can speak through a cable, taking the Atlantic cable as his type. He showed that it was practically impossible to speak with ease over a greater distance than twenty miles. Now I happen to have made a great many experiments on the subject of cables between England and the Channel Islands—between Dublin and Holyhead and other places. I have also experimented largely on artificial cables. My conclusions agree thoroughly with those of Lord Rayleigh. It is possible to hear sounds through 100 miles of cable. It is possible, but difficult, to hear words at fifty miles, but it is quite impossible to speak fluently and easily through a greater distance than twenty miles of such a cable.

This leads me to the subject of the use of underground wires. Now, in England (I am speaking of the Post-Office and principally of the large towns), we use nothing but underground wires. In Newcastle, where we have the largest telephone system—about 600 subscribers—the whole of that system is underground. The wires are covered with gutta percha, and made up in a peculiar fashion—four wires made up into a cable, and we have a metallic circuit. In this underground system at Newcastle there is not a sound—there is not a murmur—there is not a disturbance of any sort or kind. Conversation is held between subscriber and subscriber without any faults whatever. There is no notice at all of the defects of overground wires, and all the defects of telephone working have been entirely cured, but that one defect, which is rather a serious one, due to the distance through which one can speak, and which is limited. With the wires in present use conversation cannot be well maintained over a greater distance than 12 miles, the short distance being due to the fact that the wires we use are small. But there is a system in which underground wires are used that for short distances is working very well. It is the simple mode of drawing gutta-percha wires made up into a metallic cable into iron pipes. It is an old system which has been practically used in England for years. Of course, as you are aware, we have in England a very large underground system. We have an underground system between Liverpool and Manchester and we have an underground system in all our towns, and we at the present moment use nothing but gutta percha for insulation. We have several systems on trial and there seems to be a wild mania all over the country to drive every one underground. Every inventor who knows anything about telegraph wires seems to conceive it possible to have absolute underground wires. The result is that every inventor who has failed to acquire credit this side of the water comes over to our side, and we are pestered with these inventors at the rate of about 1 per week. As a rule we give them all a very fair consideration, and when they are good we give them a trial. For instance—Mr. Brooks has an excellent system of underground wires, and we have laid them down for a distance of 6 miles out of London. Then there is Callender's, which is also being tried here. I think there are 100 schemes before the world, but I do not think that there are more than 2 which are worthy of consideration, besides the plan that is now in actual practice. We see no reason to depart from that, as it supplies all our wants. I refer to the common simple system of drawing gutta-percha covered wires into iron pipes.

Prof. Rowland: As Prof. Fitzgerald has gone, and as I did not hear Lord Rayleigh's paper, I can only give you my ideas of what Lord Rayleigh ought to have said on that occasion. (Laughter and applause).

I shall base my remarks upon the fact that the equations which express the motion of the wave of electricity in the wires are the same as those which express the heating of the earth due to a periodic heating of its surface. As the earth is heated by the sun daily, the waves progress downward, and gradually become less and less as they go downward. It is just the same with the waves in the telephone circuit; that is when they pass through a cable. The laws are exactly the same. The laws in this case are of this nature. When the earth is periodically heated at its surface, the waves progress downward and get smaller and smaller for the reason that the heat is measured in this direction (indicating horizontal arrows).



This point is heated to that degree above the average temperature, and this point is cooled to that degree below the average temperature. The point *a* receives the heat. The flow of heat is in the direction from the highest heat to the lowest heat, so that all along this part the wave is colder than the one before it. So that the heat is flowing in that direction along that portion of the wave and flowing in this direction along this portion of the wave. (Arrows 1 and 2.) The size of the waves becomes smaller and smaller as they go downward. It is the same in the telephone circuit. When the wave starts out and goes along, some waves of electricity are conducted backwards as well as forwards, so that the waves diminish as they go along the wire. Now the law of that case is as follows: Supposing that this height is five times as great as the height of the next wave—it is much greater than that usually—but the ratio, whatever it is, will be the same for waves of all lengths; that is, the next wave above will be five times as high as this wave. So that you have a short wave dying out very much more rapidly than long waves, because by the time this short wave gets down to this depth there will be scarcely anything left of it. The effect would, therefore, be in the telephone circuit to throw out the waves of short wave lengths and leave you merely the long waves. Therefore, a man with a deep voice could be heard much further than a lady who had a very high-toned voice, and the sound would be greatly changed as it goes along the telephone circuit. As to how far you would recognize the voice, that is a difficult question, when you take it from a theorectical point of view. Lord Rayleigh calculated the distance at twenty miles through which one could hear respectably through a cable like the Atlantic cable. But I suppose the tone would be changed, and the voice appear different, when heard through a cable, from what it would without this effect. That is the only point upon which there is any doubt. I am sorry Prof. Fitzgerald is not here to give us the exact calculation.

Mr. Elihu Thomson: I hardly feel like speaking on this subject, but my attention being directed for a number of years to the matter of long-distance telephoning, I want to settle the matter referred to, and correct some statements which have been made. In some experiments which I made several years ago, something over seven years ago, I think, the results of which were published in the Journal of the Franklin Institute in the spring of 1878, I called attention to the fact of the great facility with which telephone messages could be exchanged along a line which was in a very leaky condition. I mentioned the case of two wires placed at my disposal in Virginia by the telegraph company: two different wires, one of which was excellently well insulated, and the other one of which was a line which was on the ground for a large portion of the way. They told me, after beginning operations, that as to the line that was on the ground, probably I would have no satisfactory use of it. But I found much to my surprise, in trying the two lines, although it was impossible to work the Morse system over the line which was on the ground (except occasionally when it would be lifted by some passer-by, who might drag the wire or lay it on the top of the railing, or on a dry day), that I could always use the telephone, and use it very satisfactorily; whereas, on the other wire, a well insulated wire, belonging to the Baltimore & Ohio Telegraph Company, on the poles all the way, I always had a great deal of trouble from this so-called induction.

I mentioned also in this paper at that time the fact which Mr. Lockwood has mentioned to-day, that the line giving the most trouble as to working was a line running in the direction of north-west and south-east. I have tried a good many lines, and have found that these lines are worse than many others, and are subject to the daily periodical disturbances he speaks of.

Mr. Lockwood spoke of the fact of induction being introduced on telegraph lines. Now, when telephone lines are running on the ground I have found that there is no necessity for them to run parallel with each other. I have observed induction from the telegraphic wire when the wire run at exactly right angles to the telegraphic wire, but not touching the same poles. I think that this phenomenon, though it is one similar to the one referred to in the statement made by Prof. Bell, and discussed in a section of the American Association the other day, that it was merely due to the fact that the terminals of these crossed telephone wires were placed in the field. The ends were at different potentials in some way, due the distribution of the current from the telegraph wire, and hence the messages could be observed. I had a striking instance of that kind at that time. I found on one occasion that I could read telegraphic signals which were being sent by the Morse system and what was going on was perfectly intelligible to me. The message was being transmitted from Boston to New York. I tried to find the arrangement of the lines around the surrounding country, and I found no line within one quarter of a mile of the line I was working on. There was one short circuit running perhaps two hundred yards. The lines that did run in the neighborhood were as nearly as might be at right angles to the wires on which we were working with the telephone. Even at this great distance, having a very short line and taking it from a telegraph line of such length as the line between New York and Boston, the sensitiveness of the instruments was such that there was no difficulty then in reading those signals. I would catch a few words and then it would disappear for some time. It seems to me to point out some of those troubles of the Morse system and to show that they may arise in that way when there is no direct leakage from the pole or from induction or anything of that sort.

Mr. Lockwood: If there is no more to be said by others I would like to make a few concluding remarks, as I have to leave for New York to-morrow morning. Mr. Preece, in his very gentle criticism on my remarks, stated as a preliminary that it was my duty, as I declared, to know what was going on in the surrounding world in regard to the subject in hand and I had neglected it. I have much pleasure in declaring that that which I omitted in reference to what he spoke of afterward, I omitted deliberately. I did not think it necessary nor did I regard it within the scope of this question to enumerate every remedy which had been proposed, whether adopted or not, or even some that had been adopted. With respect to the method of twisting the wires around one another, of which a fragmentary view has been displayed upon the black-board, I must say, that was one of the first that was brought under my notice, and that while sometimes it worked very well, at other times it did not work at all. The results obtained from it were by no means pronounced enough to compensate for the extreme difficulty incident to its construction and maintenance. I perhaps have labored under some disadvantage from the fact that I was compelled to omit reading a portion of my paper. If I did not say, I certainly meant to say, that a metallic circuit was not an effective circuit only in so far as the two wires concerned were equally distant from the source of disturbance. Mr. Preece also stated that I omitted to mention one of the worst troubles about terminal earths. If my memory is right, I mentioned one of the chief sources of trouble we had experienced was the over-charging of terminal earth-wires. I can, however, mention here that in large central stations where a number of telephone wires converge we find it readily practicable to dispense with terminal earth-wires altogether, letting each wire find its earth in all the other wires. It does not make any radical difference. I think sometimes it works a little better; that is, it is an advantage. Where there are a great number of wires two-thirds of which may be engaged at once, the joint resistance of the others is not a sufficiently low resistance.

We have also used the induction-coil method of repeating from a long line circuit to a single line, and if I recollect right, I tried it in the autumn of 1879. While, as he says, we cannot readily hear from one end what is said from the other, still we can talk upon a single line at one end, and repeat our words over the double line on to any number of single lines. Results in that case were not very good.

We in this country have to cater to a great extent to the public mind, and when the public mind wants a telephone it wants a good one, or it does not want any.

I cordially agree with Mr. Preece in what he said about the length of cables over which it is possible to work. I have tried various lengths of subterranean and subaqueous cables, among others a cable from Newport to Block Island, which I think is twelve miles long. While it is possible for persons to carry on a conversation who are familiar with telephonic communication and who have experimented considerably with telephones and telephonic circuits, and to understand what is said between the two ends of that cable—which is a very fair one, I think it belongs to the Government—it is by no means so easy for persons who only handle the telephone as a means of conversation between friends and in business, to understand. We have to make a distinction between practicable and practical. It is perhaps wider in business than we should make it in science.

In respect to the point noted by Prof. Rowland at the conclusion of his remarks, that most likely the voice of a lady would not carry so far over a cable as the hoarser tones of a man, I may say that practice bears that observation out; that is to say, the female voice is better adapted to short circuits, and it is with some difficulty adapted to long distances. For long distances the bass voice is much more effective—whether overhead or underground.

I perhaps should have mentioned, and I regret that Mr. Preece is not here to hear me, that I have taken particular pains to read the discussions which were led by himself and Prof. Hughes in 1878. I have read with great interest and profit what has been written on the subject; never-

theless, I would say that the number of wires we have to work in this country and the number of wires they work in England are quite different. Where they work ten wires I think we frequently work one hundred. Mr. Preece in one of his speeches here, which are always replete with interest and instruction, ventured to state that the "Researches" of Faraday should be the electrician's Bible. I myself am ready to say that, having received so much benefit from Mr. Preece's writing, I think we could venture to add his work to the list and call it the "Electrician's New Testament." (Applause.) The gentleman who spoke last also referred to his remarks published in the Journal of the Franklin Institute in 1878. I did not have the good fortune to hear those remarks, nor the pleasure of reading them at the time in the Journal of the Franklin Institute. I have since read them and noted what was stated therein, and I am cordially disposed to agree with everything there stated. However, the fact that the telephone could be more easily worked over a leaky line was noted, and verified at an earlier date than that by Prof. Bell, who used to stand on the ground and hold one end of the wire in his hand, and use himself for the ground.

In conclusion I should like to say that, while we may have very many satisfactory laboratory experiments, and while I may be able to converse with San Francisco or Denver in occasional experiments, it is quite a different thing to do it every day. Because I can do it one day, I do not wish it understood that I can do it every day. Conditions vary from day to day very materially.

Prof. Henry S Carhart: There is one word I have to say with respect to Lord Rayleigh's paper. I heard the most of that paper. I was not in at the beginning of his explanation and therefore did not take down the formula. But Prof. Rowland is entirely correct, I think, in the general drift of Lord Rayleigh's argument. The manner in which Lord Rayleigh arrived at the result of twenty miles was, of course, to take the constants of the Atlantic cable, and substitute them in his formula, and also to assume a note of given pitch, and then the other tones would be cut off exactly as explained.

Mr. Koyle: In reference to the subject, I should like also to say a word. I think that the conclusions which we have seen just now may be materially changed by another condition, and that is—leakage. It is very easy to understand how, if we have two parallel wires, and you start a current in one of them in that direction, that it will start a momentary current in the opposite direction in the other. But if you have a small leak across, you will find that it will start a current in an upward direction in that wire, the leak and the induction balancing, and the result upon this wire being *nil*. Consequently, if you have a cable made which has a proper amount of leakage (and this expression "proper amount" is very important), you may have a very successful cable, I believe. There is in this country a cable a few miles long under water, containing seven wires, which makes a continuous length for the distance of fourteen miles. That cable was put down there some three or four years ago, and for a long while—I am not certain whether it is so to-day, but I know for a year or two—that cable was just as good for telephonic purposes as any two miles above ground in this country. There was no induction noticeable; there was nothing that was not desirable. I knew the gentleman who had charge of the cable, and he used to experiment upon it regularly. His explanation of the theory of a good cable was entirely unsatisfactory, but I think this is the reason—that his cable leaked. The cable under water could leak, and, consequently, there was enough leak to prevent the induction.

There is just one word more. Last winter I had occasion to construct a thing like this for a gentleman, with which to make some rapid delicate tests. I had a long line here, a make and a break circuit, and two telephone lines parallel to it, at a distance, say, of two feet A small current from one or two cells was going through the make and break circuit, which could be distinctly heard in the two telephones on the line which ran parallel to that line at a distance of two feet. In the first place I held the wires to the same ear. It got very tedious, and then I tried the two telephones, one at each ear, and then the sound might be harder in one ear than in the other. But I adjusted the telephones until the sounds were equal. I lowered the make and break effect until it was very weak. If you will suppose this to represent one ear, that the other, and a telephone wire running to each; after they have been adjusted to equality of sound, the sound from the right telephone might become a little louder. The sounds when they were one and very low, instead of appearing to be in my ears, appeared to be directly at the back of my neck. But if you increase slowly the effect upon the telephone attached to the right ear, the sound will quietly move around in the direction of the right ear. After a while I developed the thing somewhat further. I had a scale made that came down and around from this ear up to this one, and I had that marked with 180 degrees from ear to ear, and had a boy stand behind the back of my neck. I had one telephone attached, so that it was stationary. But when I put the other telephone to my ear I could move the sound around the back of my neck; I could hear, or rather feel the sound there, and the boy would read off the number on the scale, and I could tell the difference of intensity between the two telephones in that way within something less than ten per cent. The theoretical reasoning at the bottom of it I do not know; all I know is the facts themselves, which I can guarantee and am prepared to prove.

Adjourned to Saturday, at 10 A. M.

The "Mackay-Bennett" Cable Steamer.

Messrs. Elder & Co. recently launched the Mackay-Bennett, a steel twin-screw steamer 270 feet long, 40 feet broad, 25 feet 6 inches deep and 2,000 tons gross, for the Commercial Cable Compauy, for the purpose of repairing and keeping in order their new Atlantic cables. She is built with an elliptical stern, and the stem is curved forward in the form of a cut-water so as to prevent the cable fouling the forefoot. A double bottom built on the cellular system, divided into four water-tight compartments, for water ballast, is fitted right fore and aft, and, in addition to this, water ballast can be carried in the cable tank cones. The number of water-tight bulkheads is five, four of which extend to the upper and one to the main deck. Large bilge keels are fitted, so as to reduce the rolling of the vessel when laying cables in heavy weather. A rudder is fitted at each end of the ship, with means of locking the same from the upper deck when not required for manœuvering. The tanks for stowing telegraph cable are three in number, two of them placed forward of the engine and boiler space, and one aft, and their collective capacity is 27,200 feet. Paying out and picking up machinery is carried on the upper deck, and the cable is led over pulleys supported by strong iron girders projecting over the bow and stern. The vessel will be fitted with two sets of compound inverted cylinder engines, each with two cylinders, one high-pressure cylinder 25 inches in diameter, and one low-pressure cylinder 50 inches in diameter, with a stroke 3 feet. The high-pressure cylinder has a valve of the equilibrium piston type, and the low-pressure cylinder has an ordinary double ported slide valve. These valves are worked by the usual double eccentric and link motion. The surface condensers are placed at the back of each engine, the water being supplied to them by a centrifugal pump. The air feeds and bilge pumps are worked by levers connected to the piston-rod crossheads of the low-pressure engines by two cylindrical single-ended multitubular boilers, each of which is fitted with four of Fox's patent corrugated furnaces. The boilers, which are made entirely of steel, are constructed for a working pressure of 100 pounds per square inch.

The Telephone in the Patent Office.

Messrs. Fisher, Clarke, and Bates, Examiners-in-Chief of the Patent Office, have rendered their decision in the matter of Voelker against Gray and others—a patent interference case involving the invention of the speaking telephone. Of the 14 original parties there remain now only 6, namely, William L. Voelker (two applications), Thomas A. Edison (five applications), Elisha Gray (four applications), John H. Irwin, James W. McDonough (one application each), and Alexander Graham Bell (two patents). The Examiner of Interferences had awarded priority of invention to Bell in cases A, B, C, E, F, I, J and L; in cases D and "No. 1" to Edison, and in case G to McDonough. Case G is generally regarded as the principal point at issue and practically covers the telephonic invention, for it is an application for "a telephonic receiver, consisting of the combination in an electric circuit of a magnet and a diaphragm, supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality." Before taking up the issues in detail the examiners say: "The courts have held that those seeking to overthrow patents should be held to strict proof of actual and successful prior embodiment, and the office has applied the same rule to those asking a patent for that which has already been patented to another. In this case the rule of the office is to be applied with strictness, for Bell's patent has not only not been declared invalid by any court, but has actually been sustained, and upon a record which is a part of the record here. It follows, therefore, that although satisfied from the evidence that Bell had made the invention before the filing of his application it will not be necessary for the general purposes of this case to review those portions of it which have led to this conclusion. It will be sufficient to determine whether or not the other parties have overcome his record dates."

The issues are then taken up separately and decided. Issue A is "the art of transmitting and reproduciug at a distance sonorous waves or vibrations of any description by increasing and decreasing the strength of an electric current," etc. Edison, Bell and Voelker were the principal contestants, and the decision is that "it must be concluded that Edison, like Voelker, has not overcome Bell's record dates." Issue B is "the improvement in the art of transmitting vocal sounds and words telegraphically by throwing upon the line, through the medium of a varying resistance, electric impulses corresponding to the vibrations of a diaphragm," etc. The decision of the Examiner in favor of Bell is sustained on this point, and also on issue C, which relates to the transmitter, consisting of the combination of a diaphragm and a liquid or equivalent substance of high resistance. Issue E, for an armature plate, the electro-magnet for the same and a closed circuit passing from the helix to the source of undulatory electric energy, and is also awarded to Bell. Issue F, concerning the transmitter, was not appealed and stands to Bell's credit. Issue G, "a telephonic receiver consisting of the combination in an electric circuit of a magnet and a diaphragm, supported and arranged in close proximity thereto, whereby sounds thrown upon the line may be reproduced accurately as to pitch and quality," was awarded by the Examiner to McDonough. The parties were Bell, McDonough, Gray and Edison.

After an exhaustive review of the great mass of evidence adduced upon this point and stating at length the reasons leading to the conclusion, the Examiners say: "Upon the whole, McDonough's proofs cannot be held to be sufficient to overcome Bell's record dates. We have seen that a party contesting the right of a patentee must show completed and perfected apparatus. That McDonough did not have this is clear. Had a patent been granted to him for it as described in his application, or as experimented with in June, 1875, the public would have been no wiser than before. It still would have been ignorant of the method and apparatus for speech transmission, for no instrument working upon its principle of making and breaking contact can accomplish that result. In this respect McDonough gave no more to the world than Reis. As was said of Reis by Mr. Justice Lowell, in American Bell Telephone Company against Spencer, a century of McDonough would never have produced a speaking telephone." Issue J, for the combination with an electro-magnet of an iron or steel diaphragm, secured to a resonant case for rendering audible acoustic vibrations, is confirmed to Bell, as is issue L, which concerns the polarized armature in the receiver. Edison's claim is supported in issue No. 1, for a spring carrying one electrode of the circuit of a telephone and constantly pressing against the other electrode and diaphragm.

It is understood that the McDonough claims are not, however, to be dropped.

The Westinghouse Engine.

Although the Westinghouse engine has only been before the public for about three years, the sales have reached such a point that it is necessary to provide for a manufacturing capacity of 100 engines, aggregating 3,500 horse-power per month, or four engines every working day. In view of this unexampled development, the Westinghouse Company have determined to adopt a new business policy. The company, as such, will no longer solicit sales direct from the customer. The capital and energies heretofore employed in this direction will now be called in, and concentrated strictly upon the manufacture. The selling department will be transferred to a few parties of high responsibility, operating in defined territories, under close contracts, of a nature to reciprocally guarantee the perfection of the engine, and the placing of the total product for cash. The effect of this arrangement is to practically double the working capacity, enabling the company to secure a larger stock of engines for immediate shipment, reducing the cost, and, by consequence, the price of the engine, and giving to the purchaser the advantage of counsel with an expert salesman, in place of a mechanically experienced commission agent. Contracts have, therefore, already been executed with the following representative concerns, whose commercial standing becomes an assurance of the relation which they and the company will sustain to the customer: Messrs. Fairbanks, Morse & Co. of Chicago, in connection with Fairbanks & Co., of St. Louis, control the product for the Western States and Territories; Messrs. Parke & Lacy, of San Francisco, Portland and Salt Lake City, for the Pacific slope, and Messrs. Imray, Hirsch & Kaeppel, of Sydney and Melbourne, for Australia and Oceanica. The trade heretofore controlled by the branch office, at 94 Liberty street, New York, is transferred to Messrs. Westinghouse, Church, Kerr & Co., whose principal offices are opened at 17 Cortlandt street, New York. This firm is composed of gentlemen who will be recognized as officers of, or otherwise connected with the parent company, but in this capacity operating as a distinct organization, with an independent capital. Mr. H. H. Westinghouse, while residing in New York, will still retain the presidency of the Westinghouse Machine Company, and will personally supervise the character of its product.

The new firm for New York enter business as contracting and consulting mechanical engineers, controlling the manufacture and sale of approved specialties. As the Westinghouse engine is not at present built above 200 horse-power, the firm in contracting for heavy plants will use such other standard automatic engines as may be best suited to the various purposes. Boilers, boiler-settings, pumps, condensers, and steam appurtenances generally are furnished, and particular attention will be paid to the designing of new applications of power.

The Cost of Printing by Electricity.

With regard to the cost of running his large printing establishment by electricity, Mr. Geo. S. Merrill, the proprietor of the Lawrence (Mass.) *American* says: "We formerly used a Baxter 10 h. p. engine, necessitating the employment of an engineer, but the employment of the Edison Company's power gives a saving in expense of more than 33⅓ per cent. The speed is uniform, and the power satisfactory in every respect." Mr. Merrill also forwards us a communication from the Treasurer of the Edison Electric Illuminating Company, of Lawrence, Mr. E. H. Lord, who says: "The current for the presses has an E. M. F. of 106 volts, is generated at our central station and conveyed by underground cables a distance of 1,365 feet to your motor. This motor is simply an Edison dynamo whose normal capacity is 23 ampères when running as a generator. In doing its present work, it requires nearly 40 ampères of current at 106 volts, when all the presses, elevator, etc., are running. The loss in the conductor is 8 per cent., and the efficiency of the motor is about 90 per cent, as a dynamo, but I have not tested it as a motor. I should not, however, expect a very high efficiency for it under its present conditions, since it is working beyond its normal capacity."

GERMANTOWN, PA.—In a few weeks the business portion of Germantown will be lighted by the Thomson Houston electric light. The Germantown Electric Light Company, which has just been granted the privilege, intends constructing the plant at once. The dynamo machines will be placed in the central portion of the town. Already a large number of the business men have given orders for lamps. George E. Wagner has been elected President and Samuel W. Wray Sec'y of the company.

Electro-Medical Apparatus at the Exhibition.

A leading physician-in-charge at one of the London hospitals, in a treatise just published on the galvanic battery as applied to medical purposes, remarks that battery and coil have become indispensable adjuncts in the hospital and consulting room for such of those, at least, who keep abreast with the rapid advances of discovery in nervous pathology. His remark is justified by the frequent reports made in medical publications of cures effected by means of electrical treatment, and by the very large display at the Philadelphia Electrical Exhibition in Class 8—Electro-medical Apparatus. Putting aside the applications of electricity to dentistry—a class by themselves—there were no fewer than twelve exhibits of electro-medical apparatus. It is evident, therefore, that this field of electrical science has been deemed worthy of cultivation by the inventive genius of the country, and that physicists and physiologists have as a consequence succeeded in adding materially to the devices and appliances by which diseases and infirmities are combated and overcome.

It may safely be said that the largest and best exhibit in connection with electro-therapeutics was that of the Jerome Kidder Manufacturing Company, of 820 Broadway, New York. It attracted considerable attention both on account of the taste shown in the arrangement of the whole and the ingenuity of the different kinds of apparatus. We take the opportunity afforded in our series of articles on the Exhibition, of illustrating a few of the various appliances made by the company. Fig. 1 shows their physicians' office electro-medical apparatus, the parts of which are easily distinguishable. It is 10½ in. long, 9 in. wide, and 7½ in. deep. This machine has four coils, and ten changes can be effected in the strength of the current. The battery is that known as the "hydrostat tip," Fig. 2, of which the jar can be tipped, as shown, so that all the plates are raised entirely out of the solution. Fig. 3 is the physicians' visiting apparatus, open. It has four coils, and gives ten changes of current. It has an upright stopper battery, and the coil-box stands upright in one end of the case, where it is hinged. Under the hinges are springs so arranged as to connect the battery to operate the coils when the coil-box is turned down to a horizontal position as in the figure. The case is about 6 in. long, 3½ in. wide and 6 in. deep. Fig. 4 is the office and family apparatus—shown in the cut without cover. It has three coils, admitting of six current variations, and is operated by one open battery. It has a bottle into which

Fig. 8.

the fluid can be poured whenever desired. The size is 8¾ × 8¼ × 7 in. Fig. 5 is the pocket induction apparatus, which is exceedingly compact and handy. It operates by means of bi-sulphate of mercury and can be had with either three coils or four. It is worthy of note that this Faradic apparatus was awarded the medal of superiority by the American Institute in 1877, the judges' report saying: "The apparatus is constructed, so far as relates to the motive powers, after the pattern of Gaiffe's celebrated machine, but the helix and rheotome are peculiar to the manufacturer's larger batteries. The merit of this apparatus consists in its ingenious combination of old and new ideas, resulting in the construction of an instrument which for its size gives a current superior in strength and variation of quality to any other now in use."

There are several other types or styles of apparatus made, but the cuts above enumerated will serve to give a general idea of what was in the exhibit, and is manufactured under the patents secured by Dr. Kidder and now controlled by the company. We illustrate also a part of the Jerome Kidder cautery apparatus. Fig. 6 is a small but powerful galvano-cautery battery, of which the case is so constructed that the elements can be suspended above the exciting fluid or lowered so as to be immersed to any required extent. Fig. 7 will give a good idea of the galvano-caustic handle and platina loop, used in connection with the battery for the excision of tumors, etc. It is an ingenious, convenient and efficient piece of mechanism, and is in extensive use. The company make also in great variety, sponge holders, adjustable electrodes, handles, needles for electrolysis, platinum cutters and burners, and the like.

Fig. 8 is an example of the way in which the current may be applied by a patient to his own body, say for the cure of nervous headache.

It remains only to be said that all portions of the apparatus are well made and thoroughly finished. The company have been awadred several medals and diplomas.

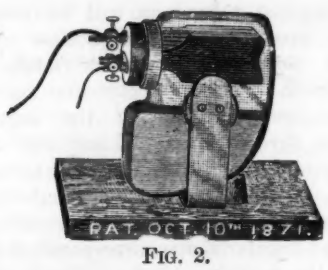


Fig. 2.

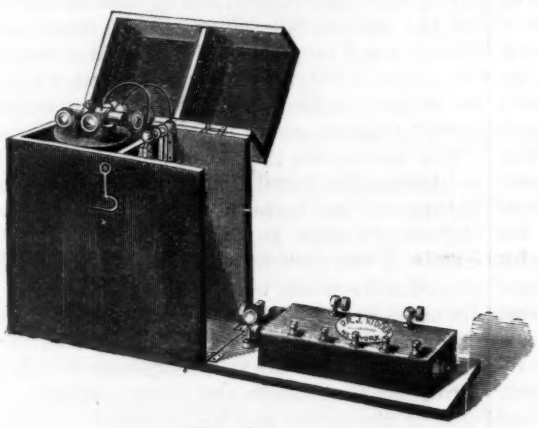


Fig. 3,

Fig. 4.

Fig. 5.

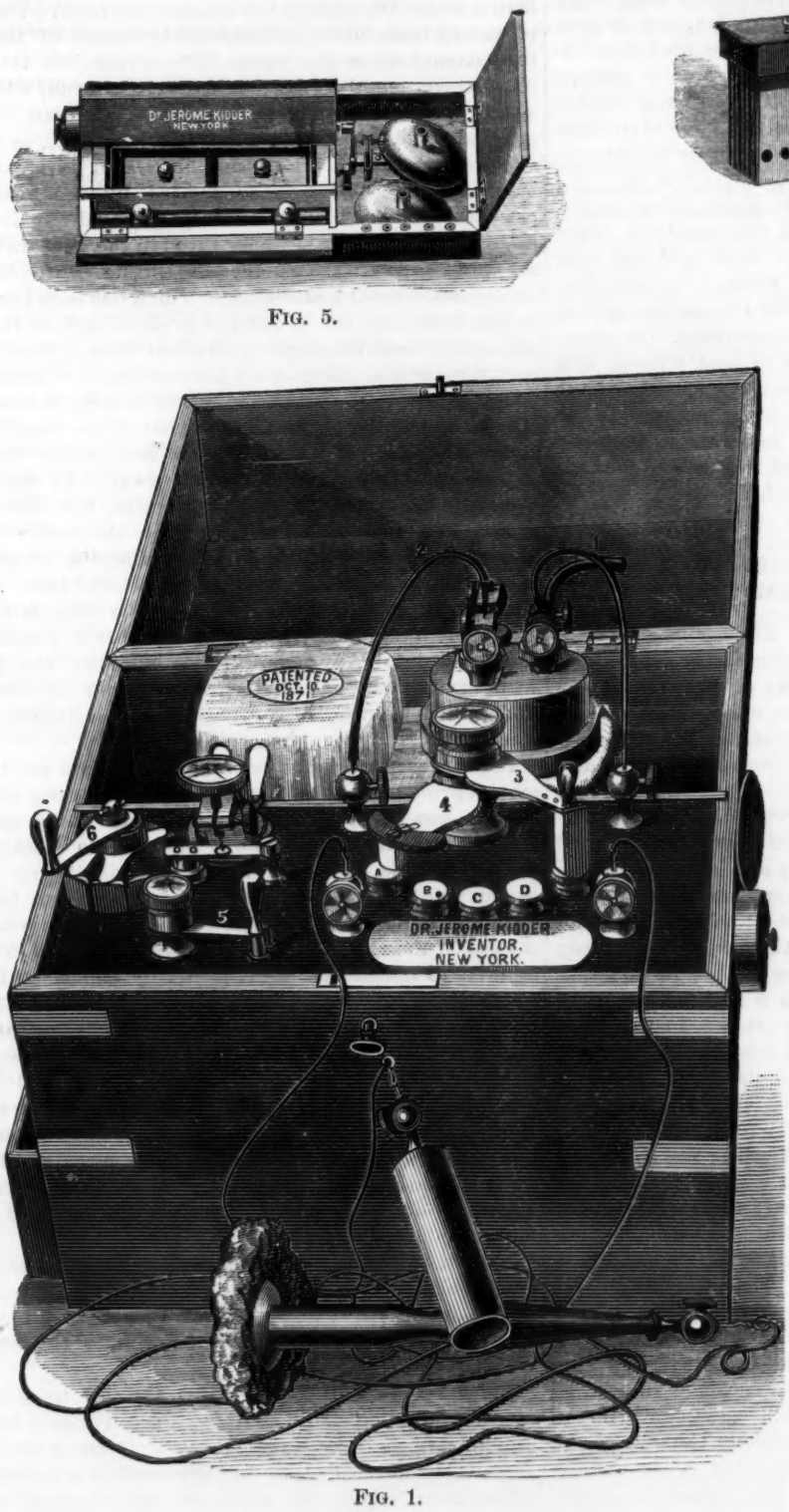


Fig. 1.

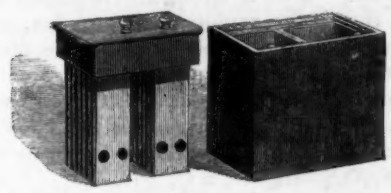


Fig. 6.

Fig. 7.

Franklin's Ancestry.

A correspondent who has read with great interest all that we have of late published about Franklin, wishes to see in type the epitaph on the monument of the parents of the great philosopher. He sends us the epitaph, and we print it as a curiosity:

"Josiah Franklin and Abiah his wife lie here interr
They lived lovingly together in wedlock fifty-five years, and without an estate or any gainful employment, by constant labor and honest industry maintained a large family comfortably, and brought up *thirteen children* and *seventeen grandchildren* respectably. From this instance, reader, be encouraged to diligence in thy calling and *distrust not providence.* He was a pious and prudent man—she a discreet and virtuous woman."

COPPER-PLATE ACCUMULATOR.—A new French accumulator has a copper plate covered with lead so as to be hermetically sealed. By means of this copper core all the secondary plates are reached at once by the primary current, and all the parts develop an equal electro-chemical activity.

Chemistry of the Carbon Filament.*

BY EDWARD P. THOMPSON.

(*Concluded from page* 162.)

I have referred heretofore to the subject of the loss of carbon, due to the process of destructive distillation; and now I wish to refer to it more particularly, and to point out the means which have been adopted in the lamp invented by Mr. Stanley and myself. Our object was to obtain as dense a carbon as possible, not only by producing such a chemical action during carbonization as would leave all the carbon as a residue, but also to introduce an additional amount of carbon by depositing the latter from a foreign substance introduced into the filament before carbonization, which substance would also be acted upon by chemical treatment. It may be mentioned that the carbon disappears by combining with the oxygen and hydrogen. Our process is found to cause all the oxygen to unite with the hydrogen, thus leaving all the carbon as a residue, and consequently leaving a carbon denser by 8 to 4 per cent. The process can be applied not only to vegetable fibre, but also to animal matter, which latter is employed in the manufacture of the lamps under exhibition. It is a well-known principle that sulphuric acid has a very strong affinity for water, and also for the elements of water when both elements occur in the same compound, as is the case in both animal and vegetable substances. An illustration of these principles may be observed when the acid is mixed with water. They immediately combine, with evolution of much heat. Also, if strong acid is poured upon sugar or syrup, the latter rapidly becomes hot, and intense chemical action is seen to take place. The final result is that whereas we had sugar and acid, there now appears only a mass of carbon. The acid has taken away the hydrogen and oxygen in the proportion to form water, leaving free the carbon according to the following equation:

$$C_6H_{22}O_{11} + H_2SO_4 = C_6 + (H_2SO_4 + 11H_2O).$$

This reaction may be made to take place either by the strong acid, as indicated, or by weak acid plus heat. Take some sugar, and moisten it with the weak acid, and heat gradually. If the acid were not present it is evident that the sugar would melt and turn into a thin liquid; but with acid and sugar mixed as described, the sugar turns into carbon by the application of heat without first melting, and the result is found to be a fine quality of the purest carbon; and if the acid and sugar are used in the right proportion, it is found by experiment that the amount of carbon remaining is equal to the amount calculated by the formula, which is as follows:

$C_6H_{22}O_{11}$.

$$\begin{aligned} C_6 &= 12 \times 6 = 72 \\ H_{22} &= 1 \times 22 = 22 \\ O_{11} &= 16 \times 11 = 176 \\ &\quad\overline{270} \end{aligned}$$

$72 \div 270 = 30$ per cent. of carbon in the sugar.

In the same manner it is found that sulphuric acid will blacken both animal and vegetable matter, and by the use of weak acid plus heat the substance is carbonized without loss of carbon and without destruction of solidity and density.

As our process involves these principles, and as the chemical actions have been verified by experiment and manufacture, it may be interesting and instructive to consider the process more in detail. The substance used may be any form of animal matter or cellulose; so that it will not be necessary to limit ourselves to the description of any particular kind of substance; further than to remark that we use animal matter, which gives a superior quality of carbon to that produced from vegetables. In the same manner as animal charcoal is found to be superior to vegetable charcoal in commerce, so is it found to be superior in electric lighting.

The substance is first prepared in the form of a thread. We form a mixture of sulphuric acid, water and sugar, by dissolving the sugar to saturation in a dilute solution of sulphuric acid. The proportion of water and acid is as 10 to 1. It may be noted here that this dilute acid will dissolve more sugar than the same volume of water by about 20 per cent. at the same temperature. The thread of animal or nitrogenous substance is wound upon large spools and immersed in the solution until every fibre is acted upon and until a chemical action has changed the character of the substance to some extent. This action is allowed to continue for about one week, while submerged in the liquid; but in fact it continues throughout the rest of the process, because the chemical preparation is not washed away, being allowed to remain in the substance during carbonization. The excess of it is, however, wiped away by an apparatus invented for the purpose. The amount of the chemical mixture which is absorbed increases the weight by about 50 per cent., which represents an addition of carbon to a considerable extent, both on account of the addition of the total amount of carbon from the sugar and on account of the acid causing the retention of the total amount of carbon in the animal substance. When taken from the mixture and left to stand for several months it turns perfectly black and in truth commences to carbonize at the ordinary temperature, and, if left for years, would undoubtedly turn into carbon completely at the ordinary temperature. This is not, however, our process of procedure, although it is made to coincide with it as far as possible, *i. e.*, it is carbonized as slowly as practicable. After being wiped as to the excess of acidulated saccharine matter, it is prepared for the oven as now to be described. This step of the process relates to that of being able to carbonize a larger number of filaments in a space scarcely larger than that occupied by the filaments themselves. In the preparation of carbon filaments it has been customary to form the fibre of the material which is to form the basis of the filament into the desired shape and to subject it while still retained in that form to sufficient heat to remove other substances than the carbon. Each filament has most usually been formed into the desired shape and treated separately. The process used in this lamp consists generally in supporting a large number of the filaments which are to be carbonized upon a single forming block, the contour of which is similar to that which it is desired to give to the filaments while thus held upon the forming block in their required positions, subjecting them to sufficient heat to effect their carbonization. The form of the block upon which the thread or filaments of an indefinite length is wound helically is such that when the filament is wonnd upon it, it will be bent into the form of loops which have the shape it is desired shall be retained by the carbonized filaments; and the prepared thread, after being wound upon the block, is retained in position by means of string or wire, or, in short, by a ligature wound transversely across the same. When thus prepared, the filament is cut at such points that single filaments are left each in the shape of the form. They are prevented from falling off the form by means of the ligature wound upon the same. The forms with the fibre upon them are then placed in a drying oven, which is slowly raised to a temperature of not less than 100 degrees and not more than about 300 degrees C., so as not to reach the point at which sulphuric acid is vaporized. The water in the fibre is evaporated by the heat very gradually and quietly, and the sulphuric acid remaining in the fibre and growing stronger through the withdrawal of the water and through the increase of heat, attacks and carbonizes without loss the sugar which has been taken up by the fibre. As the process is gradual and as there is present the acid, the sugar carbonizes into a hard compact mass which, being in the pores of the fibre, builds the latter up into a solid mass. In other words, it acts as a carbonaceous cement, making the structure non-fibrous and non-porous. If the acid were not present the saccharine matter would melt and run away. At the same time with the carbonization of the sugar, the fibre itself undergoes a chemical change through the action of the now strengthened acid upon it. It perhaps is impossible to state the exact chemical reactions which take place; but it is known that the nitrogen of the fibre is almost entirely removed from it, and the fibrine it contains is converted into new chemical combinations closely resembling one another and all extremely poor in nitrogen, such as leucine, $C_6H_{13}NO_2$; glycocine, $C_2H_5NO_2$, and tyrocine, $C_9H_{11}NO_3$.

The cause of these reactions depends upon the fundamental principle that sulphuric acid has a strong affinity for the elements of hydrogen and oxygen in the proportion to form water. In this way the hitherto nitrogenous animal fibre is converted into an essentially non-nitrogenous substance which will not be exploded into powder during the subsequent furnace carbonization, as would be the case if the nitrogen originally present in the fibre were allowed to remain, but can be readily converted into a tough elastic carbon of high specific resistance. If the fibre were exposed directly to the action of concentrated sulphuric acid, or of dilute sulphuric acid strong enough to attack it, it would be dissolved and destroyed before becoming fit for carbonization. However, as the acid is taken into the fibre in a dilute condition and then gradually becomes stronger, the action takes place slowly and throughout the fibre, as there is no free liquid present in which the resulting new compounds are dissolved, they being retained in the body of the fibre.

After the sugar is carbonized and the nitrogen is removed from the fibre, the forms containing the filaments are removed and placed in a crucible in a furnace to a temperature somewhat higher than that necessary to carbonize vegetable fibre, or about 3,000° F.

In the process of carbonization, the last trace of sulphuric acid is driven off and any nitrogen that may have remained in the fibre is removed in the form of one of the gaseous oxides of nitrogen, and the result is a purely non-nitrogenous carbon. So much for the chemical actions during carbonizations.

While the high heat of the furnace acts upon the ligature, it is also carbonized, but being of a weaker nature than the filament, it breaks instead of the latter when subjected to the strain due to carbonization. By the time it breaks at all, the filaments are so nearly carbonized that they retain the shape of the form and do not curl and twist as would be the case were they not held to the form by the ligature. The best material to wind the filaments upon as a form, has been found after numerous experiments to be carbon cut from coke, or the ordinary compressed carbon cakes cut into the required shape. Among the various substances tried were iron, and some other metals having high points of fusion, lime and similar refractory substances and wood. When wood is used, it is not necessary to cut the filament into individual filaments until after taken from the furnace, because the wood contracts proportionately as the filaments shrink; but the wood, however well seasoned, does not shrink regularly enough to keep the carbons in good uniform and regular shape. When iron is employed, the carbons are not of as superior a quality; for the iron will not absorb such oily products of destructive distillation as are given off during carbonization. The best substance to use is carbon, which may be employed repeatedly indefinitely; which absorbs the liquids and gases liberated from the filaments, and which at the same time is cheap and easily made. It is usually preferable to so construct the supporting forms that each complete convolution formed upon the same will produce two carbonized filaments, so that by cutting the same upon the opposite sides of the centre of the block, two loops will be formed having their ends confronting each other. In some instances it is desirable that the carbonized filament should have a greater breadth at the loop than at the ends; *i. e.*, to have it horse-shoe-shaped and not exactly U-shaped; and for this purpose it will be desirable to construct the double form of supporting block of less thickness through its centre than near its edges. In winding the carbonizable thread upon such a block, it will be necessary to provide some means for permitting the same to be drawn down by the winding strings into the concave surfaces thus formed. To accomplish this result, suitable blocks capable of taking up as much of the prepared thread as will be necessary to allow it to be pressed into the hollow spaces, are laid upon the sides of the block while the thread is being wound. These blocks are then removed and the subsequent winding of the supporting ligature presses the thread downward into the hollow or concave spaces, pressing it tightly against the surface of the forming block. By this process of carbonizing the filaments, their shape is free from any twist or curls, being of a continuous and regular shape corresponding exactly with the shape of the forming block. The forms may now be taken from the crucible, and by shaking them over a box all the carbons fall off in perfect shape, resembling in almost every property steel wire. In a crucible 6 in. $\times$ 6 in. $\times$ 6 in., 1,000 carbons may be baked, all of which may be obtained without danger of breaking one or of finding one of irregular shape.

It is well known that when animal matter is subjected to destructive distillation it swells to several times its natural size and leaves it porous with only small trace of carbon, of a shape anything but that of the mass from which it was carbonized, and consequently unfit for use as carbon filaments, even when the greatest precautions are taken as to excluding all air and as to regulation of temperature. The reasons for this behavior of animal matter under heat are in consequence of the presence of nitrogencus substances and a large quantity of water held both by absorption and by chemical combination. The nitrogenous compounds explode into gases with slight but comparatively strong detonations, and the water turns into a large quantity of steam, both of which cause a swelling and numerous eruptions, while the nature of the chemical reactions causes the carrying away of carbon in the form of gaseous compounds. By the simple process of soaking the animal or other varieties of nitrogenous substances in a saturated solution of sugar in dilute sulphuric acid for about one week, and then gradually heating to the highest temperature without previously washing out the chemical solution, there is obtained a carbon filament of high specific gravity, and of considerable elasticity, hardness and strength.

Another new departure in the application of the hidden principles of chemistry to electric lighting is seen in the manufacture of the Weston lamp. In one of the 18 large volumes of Gmelin's treatise on chemistry are discovered the principles of the Weston process; but from the principles as there stated, no one but Mr. Weston probably would ever have attempted to apply them to the manufacture of the carbon filament. It is only by his persevering energy and repeated experiments that he ever succeeded in making a sizable and homogeneous mass large enough to make even one filament.

In Gmelin it is learned that when certain nitrogenous substances, such as gun cotton, collodion and albumen are subjected to the action of sulphide of ammonia, protochloride of iron or tin, or cupra ammonia, the substance will thereby be deprived of its nitrogenous compounds and will be reduced to a composition approximately similar to cellulose. I do not quote this word for word from Gmelin, but only from my memory of about a year and a half. These reducing agents have a strong attraction for oxygen, so that when left remaining exposed to the air for a short time a yellowish precipitate is formed which consists of the oxidized reducing agent. Sulphydrate of ammonia has a strong attraction not only for free oxygen but also for oxygen occurring in other compounds, so that when a nitrogenous substance is placed in the sulphide the oxygen is taken away in part from the nitrogen, while the remainder of the oxygen and nitrogen form one or more of the lower gaseous oxides of nitrogen, which escape and leave the substance practically free from nitrogen. This is the result of our investigation towards the exact chemi-

*A paper read before the American Institute of Electrical Engineers, at Philadelphia, October, 1884.

cal changes which take place, and which may or may not be found to be correct by further experiment. At the time of Mr. Weston's announcement of his investigation in this direction, we tried the manufacture of some experimental carbons according to his suggestions. We noticed great difficulties in obtaining any appreciable quantity of the substance which he has decided to call tamadine. Upon pouring the sulphide upon collodion, the latter at once turned opaque and white in spots and appeared fibrous; while upon investigation it proved to be non-fibrous. At these spots it was considerably tougher than the original collodion, but not so homogeneous as the collodion. By flooding the collodion with an excess of the sulphide, the spots of the changed substance were larger; but by repeated experiments we found it apparently impossible to obtain a large enough quantity for carbonization in the form of a filament. It was apparent, however, that the difficulties were due to mechanical and not to chemical difficulties. I have since learned that Mr. Weston is obliged to use large excesses of the sulphide, to use it at a fixed specific gravity and at a constant temperature. The quality of the results is best appreciated by viewing the samples on exhibition.

Lipmann's Electro-Dynamometer.

The following appears as a brief description of M. G. Lipmann's electro-dynamometer: A small parallelopipedal chamber filled with mercury and communicating laterally with the two branches of a manometer is supported in the centre of a bobbin of copper wire. The current passes through the wire and thus through the mercury, and the manometer shows a permanent deviation due to the electro-dynamic action exerted on the mercury by the remainder of the circuit. The deviation is strictly proportional to the square of the intensity of the current, and the apparatus can be used to measure alternating currents. All the parts of the apparatus are rigid and immovable with the exception of the mercury, and even in this latter case the points at which the current enters and leaves the mercury have an invariable position with respect to the rest of the apparatus. In consequence of this rigidity the form and sensibility of the apparatus remains perfectly constant. This instrument can be constructed to measure currents in absolute measure, for the pressure p, indicated by the manometer, is connected with the intensity I by the formula $p = \frac{C}{E} I_2$, where E is the thickness of the layer of mercury and C is the intensity of the magnetic field produced at the centre of the bobbin by a current of unit intensity. The former is measured directly. The latter is deduced from the dimensions of the bobbin and increases indefinitely with the number of turns of the copper wire. In the mercurial galvanometer both the numerator and denominator in the expression $\frac{H}{E}$ have a maximum limit.

The Type-writer in Telegraphy.

At the International Electrical Exhibition in Philadelphia we saw an operator—Mr. James W. Sullivan—receiving from a Morse sounder at a fair rate of speed and copying the messages in beautiful style on a type-writing machine. The sounds from the Remington and the sounder did not appear to interfere with each other, and the operator seemed to receive with much more ease than with pen or pencil, while the copy was as clean, neat and plain as though it came from the printing press. Mr. Sullivan pointed out a boy in the department in which he was working, who, though not a telegraph operator, could print 75 words a minute in fine style from dictation.

The thought occurred to us that any company which desired to make the best use of its wires, and at the same time earn a reputation for neatness and speed, might do so in this way. We can point out an old, almost forgotten system of sound telegraphy (Morse code) by which very near or quite 75 words per minute can be transmitted over a single wire. An expert sound reader might thus, with a type-writer, turn out messages in excellent shape—in fact, in the clearest and cleanest of print—at double the speed now usually attained. One of these considerations alone would prove a great boon to that portion of the general public not apt in deciphering the hieroglyphics now frequently turned out as "messages."

We are aware that changes in systems and methods of telegraphing are not liked by operators, as was conspicuously shown when it was proposed, ten years ago, to do away with "spaced" letters and to adopt the identical code used in nearly all the civilized nations of the world, outside of the United States. Our present Morse system has been worked, year in and year out, for forty years, and, in point of fact, it has been the best yet brought to notice, because the operator receiving keeps his busy quill always even with the sender's key. In all automatic systems something is saved in "grinding" the matter over the wire, but as it must all be subsequently copied from the tape by operators—not to mention the time lost in punching the slips before sending—the public gets a service inferior to that afforded by the old Morse sound system.

But, where there is already a system, lying dormant, where messages can be transmitted and easily read by sound at a speed more than half again as fast as the present sound system, it may be capable of demonstration that a type-writer in the hands of an expert sound reader might work wonders for the telegraph companies, the public and the better class of operators. The combined telegraph operator, stenographer and type-writer is, we think, one of the bright rifts in the dark clouds of operatorial life.

The rapidity with which the type-writer is now superseding all other forms of copying is not less remarkable than the increasing dexterity of its manipulators; and the proposition stands that if the speed of a Morse circuit can be raised to match the speed of a first class "writer" (say, to send and receive 75 words easily per minute), the service will have been improved.

Such a system would, of course, require more expert operators, but that is what we need—a higher standard. We must admit that the service now is excellent, but its excellence must be progressive excellence. Good workers command good pay; the professional botches, cobblers and shirks should look out for themselves. The old-time, lackadaisical style of floating along with the tide is certainly very pleasant, for it is easy; improved methods may be a trifle harder, but power will grow with every effort.

To improve and elevate the profession is better than issuing idle threats against "colleges" which are turning out so-called operators by the squadron. The paralyzing self-assumption which says that no more men or women shall be taught the business, as it stands to-day, will not bear the test of logic, and so long as men are content to remain where they are they will continually invite the accession of an inferior grade of recruits.

A Storage Battery for Miners.

At the last meeting of the Engineers' Club of Philadelphia, Mr. C. Henry Roney showed a portable storage battery for mining and exploring purposes, with small incandescent lamps, illustrating his remarks with blackboard sketches. The battery shown was a modification of Planté's, devised by Dr. E. T. Starr, of Philadelphia, the electrodes consisting of V-shaped plates of sheet-lead arranged over each other, the convexity downward, with a slight interval between them, their ends attached to a lead frame by "burned" joints, the interstices between the plates being filled with finely divided metallic lead, exposing a large surface to oxidation and reduction when subjected to dynamic electric or voltaic energy, and, in turn, giving off a large percentage of the "stored" energy to incandescent lamps placed in the circuit. The battery shown measured 8¾ inches long, 2¾ inches high, and ¾ inch thick, and would maintain a small two-candle incandescent lamp at incandescence for about one hour. A battery sufficiently large to run an eight-candle lamp for ten or twelve hours would not be too large or heavy to carry conveniently for mine or other underground exploration.

THE TELEGRAPH.

"OLD SOLDIERS" AND YOUNG.—An army officer declares that the laziest creature on earth is the regular soldier. It is plain to be seen that this man has never made the acquaintance of the district telegraph boy.—*Philadelphia Press.*

A CANADIAN CABLE.—A dispatch from Ottawa, dated October 24th, says that the Government will place the sum of $140,000 in the estimates during the coming session of Parliament to defray the expense of laying a cable between Nova Scotia and Sable Island. Owing to the rocky nature of the bottom over which the cable will run, it will be necessary to lay a shore cable the whole distance, which will cost three times as much as an ordinary ocean cable.

THE TELEGRAPH IN CANADA.—The report of the Public Works Department points out that Canada possesses greater telegraph facilities than either the United States or any European country. The number of offices in Canada is 2,359, or one to every 1,914 of population, while in Switzerland the proportion is one to 2,500; in the United States, one to every 3,700; in Germany, one to every 4,300; in France, one to every 6,231, and in Great Britain one to every 6,503.

THE TELEGRAPH COMPANIES IN TEXAS.—A dispatch from Paris, Texas, of Oct. 23, says: The court to-day heard application for 11 injunctions against the Baltimore & Ohio Telegraph Company, brought in the name of farmers and land owners along the Texas & Pacific Railroad Company through this county, to restrain the Baltimore & Ohio Company from erecting its telegraph line along the right of way of that road. The land owners represented the interests of the Western Union Telegraph Company, which company, after having been defeated in their previous applications in their own name and that of the Texas & Pacific Railroad Company, are said to have bought up from the farmers their interest in the railroad right of way and applied to the court through this medium, claiming that the condemnation of their land for railroad purposes still left them entitled to damages, now that it was proposed to condemn the land for telegraph purposes. The court refused all these applications on the ground that, while the damage to the plaintiff, if any, was trifling, the damage to the telegraph company by stopping the work would be irreparable. The farmers are happy, having already received their money from the Western Union Company.

THE TELEPHONE.

THE NEW ENGLAND COMPANY.—Mr. F. J. Boynton has been elected as temporary secretary and acting auditor in place of Mr. Glidden, resigned.

ON AN UNDERGROUND RAILWAY.—In order to secure better working of the signal system on the new Inner Circle Railway, London, a continuous line of telephones between the signal-boxes has been established. It has already been proved to be of great use.

ENGLISH APPRECIATION.—The English electrical papers, having received a copy of the List of the New York and New Jersey Telephone Company from Mr. W. D. Sargent, pass compliments upon it, and express the wish that telephone companies in England knew as well as does this company the way to obtain and keep customers.

THE TELEPHONE IN ITALY.—The latest telephone statistics for Italy, brought down to August, show that the high rate of increase is being maintained by the Italian General Telephone Company. The figures in parentheses represent the increase during the year: Turin, 1,140 (563); Milan, 1,087 (567); Genoa, 828 (313); Florence, 742 (221); Bologna, 436 (118); Leghorn, 317 (77); Rome, 1,351 (428); Naples, 641 (102); Venice, 190 (5); Palermo, 333 (80); Messina, 124 (11); Catania, 181 (51); totals, 7,370 (2,536). In Turin, Milan, Genoa, Florence and Bologna amalgamations have been made during the year with with competing companies.

THE CONSOLIDATED TELEPHONE CO.—We have received a copy of the report of Mr. George F. Shaver, President, to the stockholders of the Consolidated Telephone Co. of this city, operating mechanical telephones. It appears that the company have received in cash, from June 1, 1883, to July 31, 1884, the sum of $19,354. Outstanding bills amount to $23,697. The capital stock received from sub-companies is $150,000, and $130,000 more has been earned, but not issued. Cash paid out, covering office furniture, machinery and stock on hand, is $14,318. Cash on hand in bank and petty cash, Oct. 18, was $5,036. This is a good showing, we judge, for a mechanical telephone company.

THE ELECTRIC LIGHT.

THE LIGHT AFLOAT.—It is noted that every one of a number of large steamers launched during last month on the Clyde was provided with the electric light.

A REMARKABLE RECOGNITION OF MERIT.—It is highly significant that the corporation of Manchester, England, a city owning gas works, has given an order for the lighting by electricty of its new Victoria Hotel.

A HAMMER LAMP.—A lamp has been patented in Belgium, in which a hammer carrying one of the carbons has a rapid reciprocating motion imparted to it from a coil through which passes the intermittent current of one or more battery cells. Sparks are produced by the alternate contact and separation of the carbons, and the effect is that of continuous light.

PROGRESS VERSUS PROFIT.—The *Mechanical World*, England, says that it notes substantial progress in electric lighting throughout England, but adds that the progress would be far more rapid if makers of incandescent lamps would only be content with 100 per cent. profit instead of 750. It remarks, too, that the business of electric lighting is falling gradually into the hands of able men.

DETROIT, MICH.—The opinion of the Supreme Court of Michigan in which an information was filed to restrain the city of Detroit from carrying out its contract with the Brush Electric Light Company for lighting the city, was delivered at Lansing on Oct. 22d, by Chief Justice Cooley, the other Justices concurring. The Supreme Court dismisses the information, thus reversing the action of the Superior Court, of Detroit. The opinion says that the dignity of the State has not been insulted by the corporate action; its authority has not been encroached upon; the franchises it has granted have not been abused; no trust fund is being diverted, and it has not been shown that any citizen is being wrongfully or excessively burdened.

THE U. S. MAN-OF-WAR "OMAHA."—The contract with the Consolidated Electric Light Company, of New York, owner of the Sawyer-Man system (illustrated and described in THE ELECTRICAL WORLD of Oct. 25), for lighting the United States ship-of-war Omaha, has been closed by the Navy Department. The equipment is to be as complete as electrical engineering and mechanical skill can devise. This is the system now in daily operation in the new Mutual Life Building, one of the finest structures in the world, and which has also been recently introduced in Massachusetts, Virginia, Georgia and elsewhere; among other places a notable one being the Eastern Lunatic Asylum, in Virginia, the only institution for the insane in this country wholly illuminated with electricity.

ELECTRIC LIGHT RAINBOWS.—Regarding an "electrical rainbow," Mr. R. S. Newall, of Ferndene, thus writes to the *Nature* on Sept. 3: "I was one of a deputation of River Tyne Commissioners who visited the South Foreland to see the experimental lights now on trial there on Saturday night, Aug. 30. We were walking across the fields from the lights toward the observing hut No. 2, a distance of about a mile and a half. There was a fog, more or less, and a shower of rain as we were approaching the hut, and every time the electric light from 'A' tower revolved, a rainbow, very like a faint lunar bow, made its appearance. I could not see any prismatic color, and the bow was only produced by the large electric light, with carbons of 1⅛ inches in diameter. There was no bow visible from the old light, which has carbons of about ⅝ inch square, and none from either the gas or oil lights. I was informed that this was the first time such a phenomenon had been observed."

THE COST OF PUBLIC LIGHTING IN CANADA.—Judging from their contracts made for street lighting in several cities of Canada, the electric light companies, says the St. John N. B. *Telegraph*, are acting on the principle of getting what they can for the work. Winnipeg has a contract for electric lighting under which it pays about $1.25 per lamp per night for thirty nights. Toronto, for lighting a portion of its streets, pays about half as much per lamp. Ottawa has made an agreement on much more favorable conditions for lighting the streets of the entire city at 22 cents per lamp per night. In the latter case it is to be remarked that abundant water power is to be credited, in part at least, with the low rate. Still the difference is so great as to leave a doubt in the minds of the public as to what is the actual

cost to the producers of electric lighting. The difference between the extremes is much greater than in gas. The one hopeful symptom to consumers is that the latest contract, that of Ottawa, shows by far the cheapest rate.

APPLICATIONS OF POWER.

PARIS UNDERGROUND RAILWAY.—It is said that there is likelihood of using electricity for the Paris Metropolitan Railway.

THE HOLROYD SMITH CAR.—An inspection of the Holroyd Smith electric car and line, lately described by us, was made a week or two ago near Manchester, by the Manchester Association of Employers and Foremen. The whole system was commended by the members, and regarded as likely to open the way for a simple and practicable application of electricity to tramway service.

ELECTRIC TRAMWAY IN SWITZERLAND.—An electric tramway has been made between the Alps Hotel, at Chillon, Switzerland, and the Fleury Hotel, situated about 590 feet above it. Between the rails is a strong rack, and the car carries a 5 h. p. dynamo, which puts in motion a spur-wheel gearing with it. Speed is regulated by an ordinary brake and an electric brake. During the trials the dynamo has been driven by a portable engine, but for regular work it is intended to use a turbine. The current is carried by copper cables laid between the rails by the side of the central rack, and is picked up by the collectors of the motor. The weight of the car is from 6 to 10 cwt., and it will carry three or four people at an average rate of about 360 feet a minute.

ELECTRIC MOTORS AT THE PARIS HOTEL DE VILLE.—The ventilators for the various halls and rooms of the Hotel de Ville, Paris, are a considerable distance apart, and, instead of a motor for driving each separately, it has been decided, says the London *Electrician*, to generate sufficient current at a central station to work an electric motor in connection with each ventilator. The Compagnie Electrique put down the plant, including two double-wound No. 6 Gramme dynamos, each absorbing about four horse-power. These latter maintain five separate circuits, on which are placed the different motors, working together or separately, according to requirements. They may even, in some case, be substituted one for another. They run at 1250 revolutions a minute, each giving out 50 ampères, with an E. M. F. of 110 volts. The electric motors which drive the ventilators are also Gramme machines, all of the No. 3 size, for convenience. Their resistance has been determined by the work which each has to do, and they make 1,450 to 1,780 revolutions per minute. Some of the electric motors are as much as 150 meters from the generators. There are 35 ventilators, requiring from 40 to 80 kilogrammeters, or 290 to 580 foot-pounds to actuate, and two 15 horse-power steam engines drive the electric generators, besides doing other work.

EXPERIMENTS AT EDINBURGH.—In order to test the applicability of electricity to street tramway traffic an experiment was made on Oct. 11, says the *Scotsman*, on the lines of the Edinburgh Tramway Company between the main entrance to the Forestry Exhibition and the Haymarket Railway station. The electric motor which has been in use in the car within the Exhibition grounds was placed in one of the ordinary cars of the tramway company. From the nature of the tramway company's lines the current of electricity generated in the dynamo was not conducted to the rails, but to two lines of copper plates placed on wood in the middle of the tramway line. The tramway car was connected with those copper plates by a small wheel and a metal cable. For this experiment those copper plates were laid down along the line of travel on the surface of the ground, but in any permanent system they would be laid underground. With one car, containing nearly a dozen gentlemen, two journeys were made from the Exhibition to the Haymarket Railway station and back. The first, in which there were one or two stoppages, was accomplished at a speed quite equal to that which is attained on the level road by horse-power. All the tests wese successful, including one in which two cars were propelled by the same motor.

MISCELLANEOUS NOTES.

DEATH OF MR. WESLEY W. GARY.—The death is announced, at Cambridge, Mass., on Oct. 22, of Mr. Wesley W. Gary, of magnetic motor fame. Mr. Gary's aim was to make the motor run itself. The sensation caused by the stories published about his reputed discoveries died out some time ago.

EDISON'S AIMS.—Mr. Edison, the celebrated electrician, in a recent interview, says the *American Engineer*, informed the public of his laudable intention to "devote five years to the elimination of the steam engine," the plan being to obtain electricity direct from the combustion of coal, instead of first having recourse to the heat of the coal, and the steam boiler and engine as intervening media. We have often maintained that such a procedure would be highly desirable; would prove the greatest discovery on record, and contribute immeasurably to the world's progress. At the same time we scarcely imagine that even Mr. Edison will satisfactorily solve this problem within a period of five years. However this may be, we desire to take exception to a statement made by him in the aforementioned interview, to the effect that "we now get out of coal about one-hundredth part of the real power we ought to get." When this statement first appeared in a daily newspaper we thought we would let it pass without notice, but now that it is being published broadcast in journals devoted to electricity, we must put it on record and call Mr. Edison's attention to the fact that he is wofully mistaken. It is a poor steam plant that does not give out from the engine shaft useful available energy equal to at least 10 per cent. (not 1 per cent.) of the total energy of the fuel, and 15 per cent. is not infrequently obtained. In fact, the modern steam appliances which Mr. Edison himself employs to furnish the power for his dynamos, probably always give out as high as 15 per cent. of all the energy in the fuel as available energy for the dynamo machines, and in some cases, doubtless, even exceed this figure. Electrical journals that have published Mr. Edison's incorrect statement may find it of interest to note these points and bring them to the attention of their readers.

STOCK QUOTATIONS.

Telegraph, telephone and electric light quotations are as follows on the New York Stock Exchange, Boston Exchange, and elsewhere are as follows:

TELEGRAPH.—American Cable, b 54¾, a 56½; Bankers & Merchants', b 2, a 4; Mutual Union, b 13, a 14½; Western Union, b 59⅝, a 59¾.

TELEPHONE.—American Bell, b 189, a 190; Erie, b 18, a 19; Mexican, b 1¾; New England, b 30½, a 31; Tropical, b 1¼.

The Boston *Herald* of Oct. 29 says: Bell Telephone settled back to 189½, it may be on account of the aopeal in the patent interference cases or, perchance, on the disappointment that no decision has yet been given in the Drawbaugh suit, expectation of which this week had been unwarrantably encouraged.

ELECTRIC LIGHT.—No quotation of sales. The changes in the Board of Trustees of the Edison Company are expected to cause a substantial improvement in the business of the corporation and in the price of its stock.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

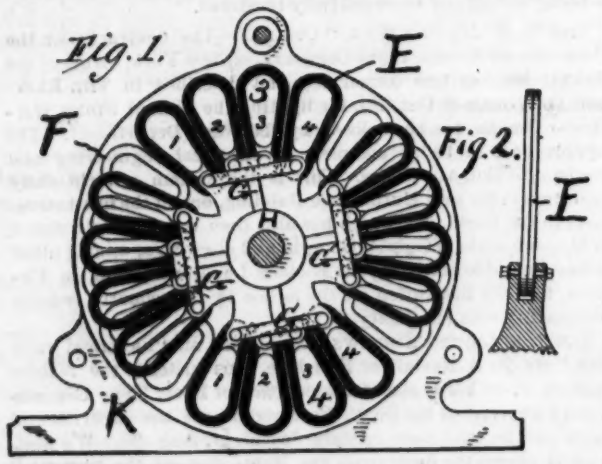
Edited by EDWARD P. THOMPSON, M. E., Electrical Expert, 9 Murray Street, New York.

PATENTS DATED OCT. 14, 1884.

Combined Electric Light and Gas Fixture; S. B. H. Vance, New York, N. Y. 306,558
Improvement on his former patent whereby the gas is not permitted to come in contact with the electric conductors. Concentric tubes are replaced by two semi-cylindrical tubes with flat sides placed face to face.

Combined Telegraphic and Telephonic Apparatus; F. Van Rysselberghe, Schaerbeek, Belgium.. 306,665
Patented in several foreign countries.
Combines with one-line circuit, of telegraphic and telephonic apparatus, a condenser acting as an inductor, an electro-magnet acting as a graduator, and a resistance, whereby the telegraphic and telephonic apparatus may be used upon the said one line without interference with each other.

Dynamo Electric Machine; W. S. Barry, London, England 306,687
The armature, Fig. 1, consisting of the oblong segments *E*, arranged about and secured to a metallic boss *H*, is mounted upon



an iron or steel spindle, which passes through and is insulated from the hub of the armature.
On either side of, and in close contiguity to, the spokes *G*, of the armature are a series of electro-magnets *F*, the iron cores of which form part of the frame *K*, of the machine.

Conducting Cord for Telephones; M. J. Kellogg, Chicago, Ill. 306,495
Relates to jacket which is braided about both insulated conductors to the point where the tips diverge, at which point the serving is continued without including either of the conductors.

Construction of Secondary Batteries; W. Lachlan, London, England 306,405
Consists of containing vessel of glass, with a cover, vertical plates provided with tags projecting through the cover and insulating strips at top and bottom of the electrodes.

Die for Making Electric Cables; W. J. Phillips and G. L. Kitson, Philadelphia, Pa.... 306,516
Two sets of grooved rollers, between which the cables are pressed into correct shape. The sets are at right angles to each other, and the centres of the grooves of the horizontal rollers are below those of the vertical.

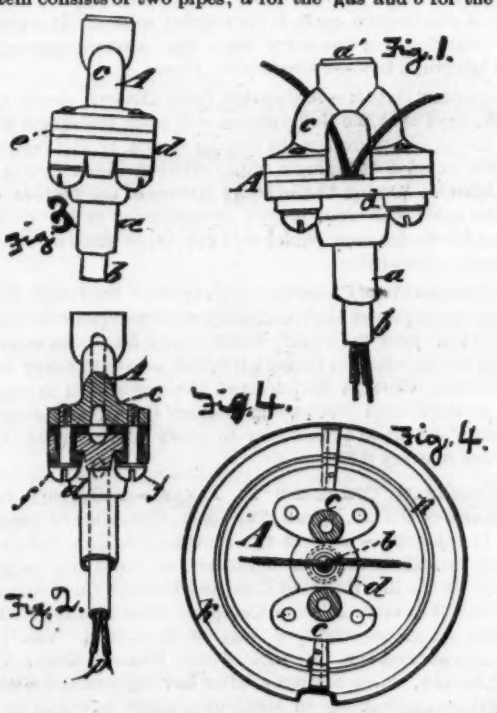
Electric Arc Lamp; E. Pickering, Brooklyn N. Y.. 306,517
Claims new arrangement of details of construction.

Electric Battery; G. F. Green, Kalamazoo, Mich... 306,684
The zinc electrode is suspended by a pin from between clamping plates in combination with a distance piece between the plates, and means of clamping the plates together.

Electric Conductor; W. R. Patterson, Chicago, Ill. 306,513
Uses lead tape as the outside covering, wound spirally, and finally applies shellac or paint.

Electrical Conductor; P. G. Gardner, Jr., North Adams, Mass 306,478
Is provided with a coating of gutta-percha, a coating of rubber or rubber compound applied over the gutta-percha, a covering of fibrous material braided on the rubber coating, and a coating of mineral or vegetable tar mixed with chloride and oxide of zinc.

Combined Gas and Electric Light Fixture; S. B. H. Vance, New York, N. Y. 306,557
Comprises many details, one of which is shown in Figs. 1, 2, 3 and 4. *A* is the coupling for attaching chandelier to ceiling. The stem consists of two pipes; *a* for the gas and *b* for the wire.



The coupling is made in the form of a Y. The upper section *c* of the bend is formed with a screw socket *a'* which receives the iron gas-pipe, while the lower section *b* is formed with a screw socket to receive the gas-pipe *a*. Channels are bored through the limbs of the upper and lower sections, which channels meet and thus form a gas passage, while the inner pipe *b* of the stem rises through the socket and screws into the top of the lower section *d* in a gas-tight manner and opens freely to the air just within the loop or bend in the coupling and in line with the socket *a'*.

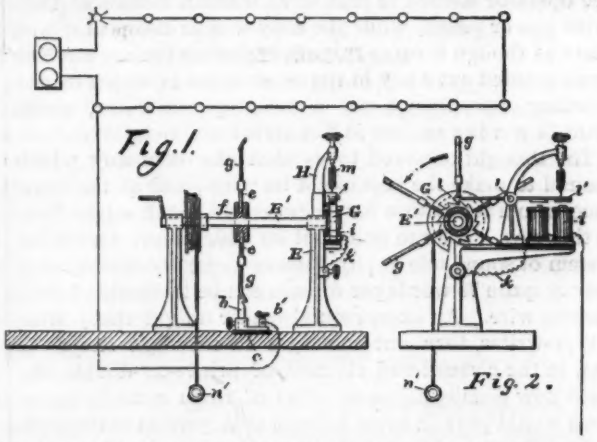
Electrical Switch Board; C. W. McDaniel and A. Barrett, Kansas City, Mo. 306,414
Consists, in a peculiar construction and arrangement of the spring-jacks of each line as it passes through the several switch-boards, in special forms of connecting-plug, in the disconnecting annunciators, and causing the annunciators of but one of any two connected lines to subserve the purpose of a disconnecting signal.

Electro-Magnetic Car-Break; J. E. Withers and G. H. Delvin, Henderson, Ky. 306,452
An electro-magnet, by means of a lever, forces a pulley against a drum on the axle of the car wheels. The pulley is thereby caused to rotate and wind a chain on its shaft. The break-block mechanism is attached to the chain and is thereby pulled into frictional contact with the wheel.

Mechanical Telephone; A. G. Holcombe, New York, N. Y. 306,616
Instead of attaching line wire directly to diaphragm, it is held under tension by a number of radial wires which connect, at a common centre, with each other, with the diaphragm and with the line wire.

Signal and Test Circuit for Telephone Exchanges; C. H. Wilson, Chicago, Ill. 306,669
Consists in connecting the testing-battery with points placed near the test-keys, so that when the key is depressed and the battery thrown to line for the purpose of testing, to see if a line wanted is in use at another board, the act of testing will call up the subscriber, provided his line is not in use.

Lightning Arrester; M. J. O'Sullivan and T. J. Houck, Baltimore, Md. 306,697
The combination with a non fusible metal point, *b*, in electrical connection with a main circuit of a shaft, *E'*, adapted to rotate



by the weight *n'*, and provided with a number of ground-connected readily-fusible points, *g*, and a ratchet-wheel *G*, an electro-magnet, *i*, an armature, *l'*, pivoted at 1, and having at its end a hook, *l*.

Telegraph and Telephone Switch; G. L. Anders, Boston, Mass. 306,457
Is operated by one or more magnets excited by currents of one polarity, and adjusted by mechanism operated by currents of opposite polarity, the switch having contacts for changing the connection of the circuit through the coils of the magnets.

Telephonic Apparatus; T. J. Perrin, New York, N. Y. 306,514
Relates to construction of the case of the transmitter in sections; and one of the electrodes is supported by a yielding and adjustable support, combined with means for adjusting.

Time Indicator for Telephone Exchanges; C. H. Haskins, Milwaukee, Wis. 306,295
Consists of a screw on a shaft turned by clock-work and circuit-closers, one for each station, which is provided with the time-service, the circuit-closers being provided with adjustable armatures, which are carried by the screw upon the revolving shaft, in combination with an annunciator at the central office and circuits.